DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

BOEING AIRPLANE COMPANY
WICHITA 1, KANSAS

EXTRA COPY
WILL NOT BE KEPT UP TO DATE

19960412 022

DOCUMENT NO. D3-2780 DATE 1-1-60

MODEL A11 CONTRACT NO.

TITLE SUMMARY OF TESTING: BMS 10-39 FUEL AND MOISTURE RESISTANT FINISH FOR FUEL TANKS

ISSUE NO. TO DATE

SHORT TITLE
(FOR CLASSIFIED DATA)

SPECIAL LIMITATIONS ON ASTIA DISTRIBUTION

ASTIA MAY DISTRIBUTE THIS REPORT TO REQUESTING AGENCIES SUBJECT TO THEIR SECURITY AGREEMENT. APPROVED FIELDS OF INTEREST AND THE FOLLOWING:

[X] UNLIMITED - TO ALL AGENCIES OF THE DEPARTMENT OF DEFENSE AND THEIR CONTRACTORS.

[ ] LIMITED - TO U.S. MILITARY ORGANIZATIONS ONLY.

THIS REPORT MAY BE DISTRIBUTED TO NONMILITARY AGENCIES NOT APPROVED ABOVE SUBJECT TO BAC APPROVAL OF EACH REQUEST.

NOTE: THE LIMITED CATEGORY MAY BE CHECKED ONLY BECAUSE OF ACTUAL OR POTENTIAL PATENT, PROPRIETARY ETHICAL, OR SIMILAR IMPLICATIONS.

PREPARED BY [signature]

SUPERVISED BY [signature]

APPROVED BY [signature] 1/13/60

APPROVED BY

SECURITY CLASSIFICATION AND DISTRIBUTION LIMITATIONS APPROVED BY [signature] 1/13/60
STAFF OR PROJECT ENGINEER

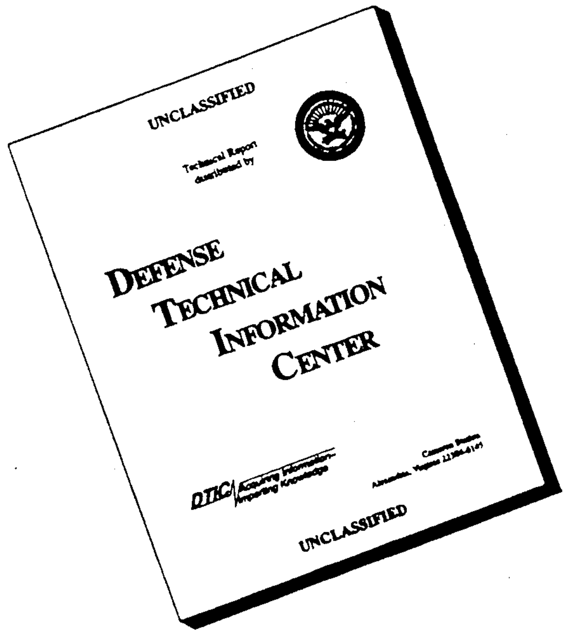
DTIC QUALITY INSPECTED 1

148
NO. OF PAGES

34100
WORK ORDER

5200-829
SERIAL

DISCLAIMER NOTICE



THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

MODEL ________ DOCUMENT NO. D3-2730

REVISIONS				ADDITIONS			
PAGE	DATE	PAGE	DATE	PAGE	DATE	PAGE	DATE
Page a, 8, 16, 20, 26, 28, 30, 31, and 89 R. Oubre	6-9-61			Pages 121A thru 121Y R. Oubre	6-9-61		

BOEING AIRPLANE COMPANY
WICHITA DIVISION WICHITA 1, KANSAS

TABLE OF CONTENTS

REVISED 6-9-61

TABLE OF CONTENTS
(Continued)

REVISED

TABLE OF CONTENTS
(Continued)

REVISED

INTRODUCTION

A. The original requirements for application of a rubber coating to the integral fuel tanks of reciprocating engine aircraft was for protection of sealant materials against the solvent action of high octane type fuels. Buna N coatings conforming to MIL-S-4383 were developed to fulfill this need and application of such coating by the fill and drain, post assembly method, provided for additional secondary sealing and corrosion protection benefits.

With the advent of jet type fuels, larger aircraft and higher strength aluminum alloys having poor corrosion resistance, the standard Buna N coating materials have failed to provide the degree of corrosion protection desired for high operational usage and reliability. To fill the need for such a high performance coating material, resistant to all jet integral fuel tank conditions, compatible with sealant materials, capable of being applied by brush or conventional spray methods and requiring less frequent maintenance and repair, a development program has resulted in qualification of a new type coating conforming to Boeing Material Specification 10-39.

B. The laboratory and flight test data reported herein show that Buna N coating conforming to MIL-S-4383 is not entirely suitable for corrosion protection of integral fuel tanks on large, high performance, jet type aircraft. The deficiencies of Buna N coating are due in part to the items listed below:

1. Lack of corrosion inhibiting pigmentation within the material,
2. Relatively low adhesion properties,

REVISED

INTRODUCTION

B. (continued)

3. Susceptibility of the Buna N Coating Material to softening, blistering and ultimate deterioration from absorption of moisture,
4. Sensitivity to chemical fuel additives, and
5. Inability to protect unsealed faying surface areas with any degree of certainty by normal post assembly application methods.

C. As these shortcomings of the MIL-S-4383 coating have become evident, an accentuated search for a better finish system for integral fuel tank areas has been made. This search has culminated in release of the Material Specification BMS 10-39. This is a thiokol modified epoxy resin material which has been tested and found to be far superior to the MIL-S-4383 Buna N coating in the following respects:

1. Resistance to moisture
2. Resistance to corrosive atmosphere, and
3. Capability of withstanding extreme environmental conditions, including some chemical fuel anti-icing additives.

In addition to its ability to withstand these conditions, the BMS 10-39 material exhibits excellent sealant adhesion compatibility by nature of its thiokol content. Such compatibility with sealant makes it possible and extremely desirable to coat parts in detail, assemble the parts and seal the assembled structure against fuel leakage by applying the sealant directly over the BMS 10-39 coating.

REVISED

INTRODUCTION (Continued)

D. The ability to finish detail parts with the BMS 10-39 coating, and then to seal the assembled structure by applying the sealant directly over the finish coating has distinct functional and economic advantages which may not be apparent at first. Such advantages are tabulated as follows:

1. Functional Advantages

a. Detail parts can be cleaned, chemically treated and painted in direct process sequence. This system eliminates excessive handling and provides optimum reliability of the finish system.

b. Coating of detailed parts provides desired corrosion protection in all faying surfaces after assembly.

c. The BMS 10-39 coated surface is easy to clean immediately prior to application of sealants. Anodized or chemical conversion coated surfaces absorb soils during assembly and are extremely difficult to clean.

d. Touch up of coating after assembly would be restricted to rivet heads and fasteners. The coating can be accomplished by brush or spray methods.

2. Economic Advantages

a. Elimination of multiple hand cleaning, hand chemical treatment and possible corrosion removal operations during and after assembly.

b. Elimination of extensive brush and spray touch up operations during and after assembly.

REVISED

INTRODUCTION

D. (continued)

c. Elimination of extensive masking of seal plane areas.

d. Elimination of necessity of painting entire major assembly such as a wing panel in areas not ideally suited for painting.

e. Will provide much upgraded service life of integral fuel tank metal structure with minimum requirement for inspection and repair.

3. Functional Disadvantage

a. The BMS 10-39 coating material unlike the MIL-S-4383 material is not transparent and therefore will not allow for visual inspection of substrate beneath the coating. However, experience dictates that any corrosion occurring to the metal substrate will manifest itself by rupture of the coating film, which of course is visually evident in any case.

b. The BMS 10-39 coating material is inherently chemically resistant once cured and tends to resist most solvent stripping materials. However, it is not impossible to strip the coating with presently available materials, and new stripping materials are constantly being evaluated to shorten the effective stripping time.

E. In view of the excellent integral fuel tank coating performance exhibited by the BMS 10-39 coating material, and the advantages to be gained by finish application to detail parts, the test programs listed in the addenda to this document and those included with this report are presented to substantuate its performance characteristics.

REVISED

ABSTRACT

A. The Fuel and Moisture Resistant Finish for Integral Fuel Tanks developed under Boeing Material Specification 10-39 will:

1. Withstand extreme environmental conditions,
2. Resist all anticipated corrosive agents within the fuel cavity,
3. Protect the integral fuel tank metal substrate from the effects of these agents for the normal life of the aircraft, and
4. Provide excellent compatibility with sealant materials as either a primer or sealant topcoat.

B. By virtue of excellent adhesion of sealant material applied over BMS 10-39 coating, aircraft parts can be finished in detail with the BMS 10-39 coating, assembled, and sealant applied directly to the coating. This system will provide the following:

1. Corrosion protection to faying surfaces,
2. Expedite finish application to parts,
3. Provide adequate protection of the metal throughout assembly sequence,
4. Provide optimum corrosion protection of assembled wing structures, and
5. Provide economy of assembly and finish procedures.

C. This economy of assembly and finish procedures is gained as follows:

1. Elimination of multiple hand cleaning operations prior to finish application.
2. Provide needed corrosion protection throughout shop assembly sequence.
3. Elimination of expensive masking of seal plane areas where present practice requires sealing directly to uncoated metal.

REVISED

ADDENDA LIST

A. Boeing Document, D3-2247, Development of a Fuel Tank Coating Conforming to BMS 10-39.

B. Boeing Document, D3-2398, Laboratory Investigation of Corrosion Protection in B-52G Integral Fuel Tank.

C. Boeing Document, D3-2434, B-52G Integral Wing Test Cube Evaluation.

D. Engineering Development Program 829, Finish System, Integral Fuel Tank.

E. Wichita Flight Test 1070: Flight Test of BMS 10-39 Fuel Tank Coating Material.

F. Wichita Flight Test 1111: Evaluation of Fuel Anti-Icing Additives.

G. Materials and Process Unit Job F-2-198: Flight Test Evaluation of Integral Fuel Tank Coatings per WFT 1070 and WFT 1111.

H. Materials and Process Unit Job S-2-425: B-52G Integral Wing Test Cube Evaluation of Sealant-Finish System.

I. Systems Laboratory Report 330-6; Finish System, Integral Fuel Tank.

REVISED

SUMMARY OF TEST REPORTS

A. Laboratory data as recorded in Document D3-2398 shows conclusive evidence that an organic protective coating must be applied to integral fuel tank areas for optimum corrosion control.

Topcoating of all component parts prior to assembly is recommended for maximum corrosion protection. The addition of organic finish to faying surfaces is strongly recommended.

B. Buna type coatings (MIL-S-4383) do not have all the desired properties for use in corrosion protection of metal surfaces in the B-52G integral fuel tanks. This is shown by results of tests reported under D3-2247. Primarily, the Buna coating is not a corrosion inhibiting type material, its adhesion properties are critically dependent on film thickness, and its basic adhesion is not adequate to allow overcoating of the finish with sealant materials. Conseq-uently, the coating of detail parts becomes somewhat impractical due to the necessity for masking of areas which will require subsequent sealing.

As a result of these shortcomings, the Buna coating is applied to final assemblies, making film thickness control difficult, and leaving inadequate protection in faying surfaces and other blind areas.

C. Recognizing the shortcomings of the Buna coatings, efforts were made to develop a fuel resistant, corrosion protective finish, tailored to meet the requirements of the B-52 Aircraft. These efforts have resulted in a promising coating material based on a modification of a strontium chromate pigmented epoxy coating.

REVISED

SUMMARY OF TEST REPORTS (Continued)

D. The basic details on test procedure for evaluation of tank design, and sealing methods and materials is contained in Document D-3-2434. This basic tank and test procedure was used as a test method for subsequent evaluation of compatiblity of BMS 10-39 and approved sealant materials.

E. The results of compatibility of BMS 10-39 coating/BMS 5-44 sealant are reported under the Materials and Process Unit Job S-2-425. The testing procedure was comparable to that reported under D-3-2434 except that the tanks were finished with BMS 10-39 coating. Under this test the BMS 10-39/BMS 5-44 system was compatible and the BMS 10-39 was considered as suitable for application to detail parts. The detail parts were assembled and the BMS 5-44 sealant applied over the coating. In small areas, BMS 10-39 coating was applied over fillets of BMS 5-44 sealant. This is representative of sealant/topcoat repair areas. Both the sealant over the coating and the coating over sealant systems were compatible.

F. A B-52G Aircraft Serial Number 57-6470 has been used in flight test of the BMS 10-39 coating system. Reports of exposure and results are given in the Materials and Process Unit Job F-2-198, Addenda G. The BMS 10-39 coating is in excellent condition. R

REVISED 6-9-61

CONCLUSIONS

A. The interior surface of the B-52G integral fuel tank must be coated with an organic finish for optimum corrosion control.

B. Finish coating of detail component parts prior to assembly is suggested for maximum corrosion protection.

C. Buna type coating conforming to MIL-S-4383 does not provide the required corrosion protection.

D. Buna type coating conforming to MIL-S-4383 must be masked from the seal plane area thereby making the application of finish to detail parts highly uneconomical.

E. A satisfactory Boeing Material Specification Coating 10-39 has been developed for use in the integral fuel tanks and in fuel tight seal areas.

F. BMS 10-39 coating/BMS 5-44 sealant system is compatible for use in integral fuel tank and fuel tight seal areas.

G. BMS 10-39 coating can be applied to detail parts and the sealant can be applied over the finish on assembled structures.

REVISED

RECOMMENDATIONS

A. It is recommended that BMS 10-39 coating be applied to the interior structural parts of the B-52 integral fuel tank and other fuel tight seal areas in place of the MIL-S-4383 Buna coating.

B. It is further recommended that every effort be made to coat the structural parts in detail so that maximum reliability and protection may be afforded faying surface areas.

REVISED

ADDENDA A

D3-2247, DEVELOPMENT OF A FUEL TANK COATING

CONFORMING TO BMS 10-39

1.0 ABSTRACT

Buna N type coatings (MIL-S-4383) do not possess all the desired properties for use in corrosion protection application in the B-52G integral fuel tanks. Efforts to develop a fuel resistant, corrosion protective coating, tailored to B-52G requirements have resulted in a promising coating material based on a thiokol modification of a strontium chromate pigmented epoxy resin primer.

REVISED

2.0 DISCUSSION OF PROBLEM

On smaller aircraft, Buna N coating of integral fuel tanks has been successfully accomplished by fill and drain methods serving primarily as sealant protection. However, the large size and complexity of the B-52G wing makes it impractical to attempt similar application methods, and it has, therefore, been necessary to resolve spray application methods for Buna N coating to supplement time consuming and poorer quality application by brushing.

Since the B-52G utilizes new fuel resistant sealants, topcoating with Buna N material is no longer required and the continued need for such coating reverts primarily to corrosion protection of the structure.

Buna N material possesses several limitations making it less desirable for the purpose of protecting the structure from corrosion. Primarily, the Buna N material is not a corrosion inhibiting type material. Its adhesion properties are critically dependent on film thickness, and its basic adhesion is not adequate to allow overcoating with sealant materials. The above factors do not permit coating of detail parts without resorting to impractical masking requirements for subsequent sealing. As a result, the Buna N coating is applied to final assemblies, making film thickness control difficult, and leaving inadequate protection in faying surfaces

2.0 DISCUSSION OF PROBLEM (Continued)

and other blind areas. Furthermore, in order to circumvent tedious, if not wholly impractical, application by brush to large areas, it has been necessary to develop spray procedures for applying Buna N coating which, in turn, does not solve any problems other than improve coating film thickness, uniformity, and saving considerable application time as compared to brushing.

Recognizing the shortcomings of Buna N material as a corrosion protective coating, efforts have been made to develop a coating material tailored to meet all the existing requirements for Buna N type material with the additional advantages of containing corrosion inhibiting pigment, and having adhesion characteristics suitable to enable topcoating with sealant materials. Such a material would allow prefinishing of detail parts, giving the desired corrosion protection to all areas of an integral fuel tank, and providing a suitable surface for sealing. These requirements have been used as a basis for establishing Boeing Material Specification 10-39, Fuel and Moisture Resistant Coating For Integral Fuel Tanks.

The material development was based on epoxy type coatings because of their well known toughness and chemical resistance characteristics. To obtain satisfactory compatibility between the coating and the sealant material, the epoxy coating was modified with thiokol resin

REVISED

2.0 DISCUSSION OF PROBLEM (Continued)

which has been, and is, the main component of integral fuel tank sealants.

Results of this development program show that an epoxy coating modified with thiokol resin provides resistance to jet fuel, superior corrosion resistance, and a good base for the integral fuel tank sealant. However, the BMS 10-39 specification is not limited to an epoxy-thiokol type coating. It is anticipated that other coating systems such as a polyurethane system, may be sufficiently developed in the future to be more desirable than the epoxy-thiokol coating.

3.0 CONCLUSIONS

A. The Enmar thiokol modified epoxy Production Number 54-36231 + T5301 Catalyst coating is resistant to jet fuel (JP-4), and provides superior corrosion protection. R

B. The Enmar thiokol modified epoxy Production Number 54-36231 + T5301 Catalyst coating does provide a good base for sealant materials. R

C. The Enmar thiokol modified epoxy Production Number 54-36231 + T5301 Catalyst coating gives excellent performance when subjected to the tests outlined in BMS 10-39. R

4.0 RECOMMENDATIONS

A. It is recommended that all interior surfaces of the fuel cell be coated with BMS 10-39 fuel tank coating.

B. It is recommended that the BMS 10-39 fuel tank coating be applied to detailed parts by spray.

5.0 SCOPE

The information contained in this Document is a summary of the following three distinct, but related job reports:

A. Job Report No. 330-2; Finish System, Integral Fuel Tank; issued by the System Laboratory Unit, 330-1, same subject.

B. Job Report NO. F-2-146; Studies on Integral Fuel Tank Corrosion; issued by the Finish Group.

C. Job Report No. S-2-346; Sealant Adhesion on Various Primed Surfaces; issued by the Sealant Group.

6.0 REFERENCES

A. BAC 5741 - Corrosion Protection in Integral Fuel Tanks.

B. D3-1932, The Application of MIL-S-4383 Coating by Spray.

C. D3-1982, Adapting Buna-N Type Coating Material For Spray Application PRR 19372.

D. BMS 10-39, Fuel and Moisture Resistance Coating for Fuel Tanks.

E. Job Report No. 330-2; Finish System, Integral Fuel Tank; issued by the Systems Laboratory; Job Report 330-1, same subject.

F. Job Report No. F-2-146; Studies on Integral Fuel Tank Corrosion; issued by Finish Laboratory.

G. Job Report No. S-2-346; Sealant Adhesion on Various Primed Surfaces; issued by Sealant Laboratory.

REVISED

7.0 MATERIALS

A. Sherwin-Williams Company, Hollywood, California.

1. BMS 10-11, Type I, E42GP13.

B. Andrew Brown Company, Irving, Texas.

1. Epoxy Coating TA-862.

C. Enmar, Inc., Wichita, Kansas

1. Epoxy-Thiokol Coating, Production Number 54-36231 + T5301 Catalyst R

D. Minnesota Mining and Manufacturing Company, Detroit 2, Michigan

1. EC-776R, Buna-N Coating.
2. EC-776-SR, Buna-N Coating.
3. EC-1527, Buna-N Coating.

E. Products Research Company, Glendale, California.

1. Sealant PR-1422.

F. Coast Pro-Seal & Manufacturing Company, Los Angeles, California.

1. Sealant - Pro-seal 890.

G. Cleaning Fluids

1. BMS 11-7 Pre-sealing Cleaning Solvent.
2. BMS 3-2, Safety Solvent, General Cleaning.

H. Test Fluids

1. W83 Jet Reference Fuel.
2. MIL-S-3136, Type I Hydrocarbon Standard Test Fluid.

I. Thiokol Chemical Corporation, Trenton 7, New Jersey.

1. Thiokol Resin LP-8.

REVISED 6-9-61

8.0 EQUIPMENT

A. Standard paint spray equipment.

B. Scott tester, number 1510, Nixon Engineering Company, Central Falls, Rhode Island.

C. Salt Spray Cabinet, Method 6061 per Federal Test Method Standard 141.

D. Condensing Humidity Cabinet operated per JAN-H-792.

E. Equipment built by Boeing Laboratories.

1. Cyclic test cabinet.
2. Constant Temperature Bath.
3. Vibration Test stand.
4. Sloshing test machine.

9.0 TEST PROGRAM

A. Accelerated Field Conditions Test

A test fuel cell, coated with BMS 10-11, Type I epoxy primer, was subjected to test fluids, physical environment, and mechanical factors that tend to duplicate, at an accelerated rate, actual field conditions. The detailed account of this test is contained in Report No. 330-2, Finish System Integral Fuel Tank, issued by the Systems Laboratory.

B. Corrosion Resistance Test

Test coatings applied over aluminum substrates which received two different cleaning treatments prior to conversion coating application, were subjected to Salt spray environment, per Reference F, for a period of 28 days. This test is a part of Job assignment F-2-146, Studies on Integral Fuel Tank Corrosion, which is still in progress, and a detailed account of this test will be issued by the Finish Laboratory upon completion.

C. Compatibility of Epoxy Coating with Integral Fuel Tank Sealant

Compatibility of epoxy with integral fuel tank sealant was evaluated using the Peel Strength Test per BMS 5-26. Peel Strength Tests were conducted on two different integral fuel tank sealants applied over three different epoxy coatings.

REVISED

9.0 TEST PROGRAM (Continued)

C. (continued)

The epoxy coatings were applied at two different film thicknesses, cured at three different temperatures, and cleaned, prior to application of sealant, using three different cleaning methods. This procedure takes into consideration the factors normally influencing the adhesion of the sealant to the coating, namely, formulation and cure of coating, film thickness of coating, and the type of cleaning medium used to prepare the surface of the coating prior to application of the sealant. The detailed account of this test is contained in Report No. S-2-346, Sealant Adhesion on Various Primed Surfaces, issued by the Sealant Laboratory.

D. Qualification Tests per BMS 10-39

Test coatings that passed the above tests were subjected to the qualification tests as outlined per BMS 10-39

10.0 TEST PROCEDURE AND RESULTS

A. Accelerated Field Conditions Test

Cleaned and conversion coated detailed parts of a test fuel cell, see Reference E, were spray coated with BMS 10-11, Type I epoxy primer per BAC 5736. After a minimum room temperature cure of 72 hours, the assembly of the cell was made in a sequence duplicating normal shop practices. In this way some sealants were applied as fillets and some as faying surface seals. The following tests were performed in the sequence in which they are listed. The total test time on the coating and the sealant over the coating is accumulative

1. Sealant Aging and Cycling Test

a. Environmental Factors

(1) Test Fluid BMS 5-26 reference fluid plus a 3% solution of salt water.

(2) Temperature - 140°F.

(3) Pressure - 12 to -3 inches of mercury for 1000 such cycles.

(4) Time - 72 hours.

b. Results

There was no detectable change in the coating or the sealant.

REVISED

10.0 TEST PROCEDURE AND RESULTS (Continued)

A. Accelerated Field Conditions Test (continued)

2. Dry-Hot Air Cycle

a. Environmental Factors

(1) Temperature - 160°F.

(2) Time - 77 hours.

b. Results

There was no detectable change in the coating or the sealant.

3. Slosh and Vibration Test

a. Environmental Factors

(1) Fluid - MIL-H-3136, Type I.

(2) Temperature - 65°F.

(3) Slosh Rate - 14 CPM

(4) Vibration frequency - 1960 cps.

(5) Time - 25 hours.

b. Results

There was no detectable change in the coating or the sealant.

B. Corrosion Resistance Test

1. Aluminum test assemblies prepared in triplicate, were cleaned prior to Iridite #14 conversion coating, and spray coated with test coatings as follows:

10.0 TEST PROCEDURE AND RESULTS (Continued)

B. Corrosion Resistance Test (Continued)

1. (Continued)

a. Cleaning Agent

(1) Alkaline Cleaner - Oakite #61.

(2) Alkaline Etch - Diversey #202.

b. Coating Materials

(1) BMS 10-15, Type I epoxy primer, E42GP13 R

(2) BMS 10-15, Type I epoxy primer, E42GP13 modified with thiokol LP-8 by mixing 3 parts by volume of epoxy base component with 1 part LP-8. (Now released as SW E42AP7 + V66KP16 Catalyst). R

(3) Enmar thiokol modified epoxy 54-36231 + T5301 Catalyst. R

(4) EC-776-R - Buna-N applied by brush.

(5) EC-776-SR - Buna-N applied by brush and spray.

(6) EC-1527 - Buna-N applied by spray.

(7) After a minimum cure period of 72 hours, the coated assemblies were placed in the salt fog cabinet per Reference F, for a period of 28 days.

c. Results

Results of this test are given in tabular form per Table I, and are the results of observation of panels after exposure.

REVISED 6-9-61

10.0 TEST PROCEDURE AND RESULTS (Continued)

C. Compatibility of Epoxy Coatings with Integral Fuel Tank Sealant

1. Each group of aluminum panels per Reference G, (four groups, 216 panels to a group), were divided into two sub-groups; one sub-group receiving 0.5 mil (dry film thickness) of a test coating, and the second sub-group receiving 2 mils. The 108 panels of each sub-group were further divided into three sets. Set I - air cured for a minimum of 72 hours, Set II - heat cured at 250°F. for 30 minutes, and Set III - heat cured at 350°F. for 15 minutes. The 36 panels of each set were further divided into three sub-sets. Sub-set I - no cleaning; Sub-set II - cleaned with BMS 11-7; and Sub-set III - cleaned with BMS 3-2. The 12 panels of each sub-set were further divided into two divisions; Division I receiving Pro-Seal 890 sealant and division II receiving Products Research 1422 sealant. After a sealant cure period of 7 days at room temperature, the 6 panels of each division were further divided into two sub-divisions. Sub-division I immersed in BMS 5-26 reference fluid at 140°F. for 7 days, and sub-division II receiving no immersion in a test fluid to serve as controls. After 7 days immersion, 3 panels of sub-division I and the 3 panels of sub-division II were subjected to the Peel Strength Tests per BMS 5-26. The four original groups mentioned above are defined as follows:

10.0 TEST PROCEDURE AND RESULTS (Continued)

C. Compatibility of Epoxy Coatings with Integral Fuel Tank Sealant.

1. (continued)

Group I - BMS 10-11, Type I epoxy primer E42GP13.

Group II - BMS 10-11, Type I epoxy primer E42GP13, modified with thiokol LP-8 by mixing 3 parts by volume of epoxy base component with 1 part LP-8. (This is SW E42AP7 + V66KP16 Converter). R

Group III - Enmar thiokol modified epoxy 54-36231 + T5301. R

Group IV - Andrew Brown epoxy TA-862.

2. Results

A summary of the results are given in graphical form per Table II. For detailed results see Reference G.

D. Qualifications Test

The following tests per BMS 10-39 were conducted on Enmar thiokol modified epoxy 54-36231 + T5301 coating. R

1. Metal anchorage - no failure.
2. Fuel and Water Resistance - no failure.
3. Humidity Resistance - no failure.
4. Low Temperature Flexibility - no failure.
5. Fuel Contamination - non-volatile less than 1 mg per 260 cc of test fluid.

REVISED 6-9-61

10.0 TEST PROCEDURE AND RESULTS (Continued)

D. Qualification Tests (continued)

6. Distilled Water Resistance - no failure.

7. Jet Reference Fuel - no failure.

8. MIL-O-5606 Fluid Resistance - no failure.

11.0 Salt Spray Exposure – 28 Days

Coating Material	ALKALINE CLEANED PRIOR TO IRIDITE 14		ALKALINE ETCHED PRIOR TO IRIDITE 14	
	Coated after Assembly	1/2 coated before Assembly	Coated after Assembly	1/2 Coated before Assembly
BMS 10-11 unmodified	Small spot of surface Corrosion at edge of faying boundry	approx. 5% of uncoated area shows surface Corrosion	NO FAILURE	Some corrosion around bolts on uncoated areas
Enmar 54-36231	NO FAILURE	100% surface corrosion on uncoated area; few shallow pits on coated area	NO FAILURE	Some corrosion around bolts on uncoated areas
B 4510-59 SHERWIN WILLIAMS	NO FAILURE	75% surface corrosion on uncoated area	NO FAILURE	10% of uncoated area shows surface corrosion
EC-776-SR sprayed	Very slight surface corrosion on edges of faying boundry	Severe corrosion on uncoated area; 25% surface corrosion on coated area	Very slight surface corrosion on edges	10% of uncoated area shows surface corrosion; some corrosion around bolts-coated
EC-776-SR brushed	10% of area shows surface corrosion	Severe corrosion on uncoated area; 50% of coated area shows surface corrosion	Very small spots of surface corrosion over all areas	Slight corrosion around bolts on uncoated area
EC-776-R	50% of area shows surface corrosion	Severe corrosion on uncoated areas; 90% of coated area shows surface corrosion	20% of area shows surface corrosion and it is concentrated on faying edge	Slight corrosion around bolts on uncoated area
EC-1527	Slight corrosion around bolts	90% of uncoated area shows surface corrosion; slight surface corrosion area adjacent to coating boundry line	NO FAILURE	Slight corrosion around bolts on uncoated area

TABLE I

R

R

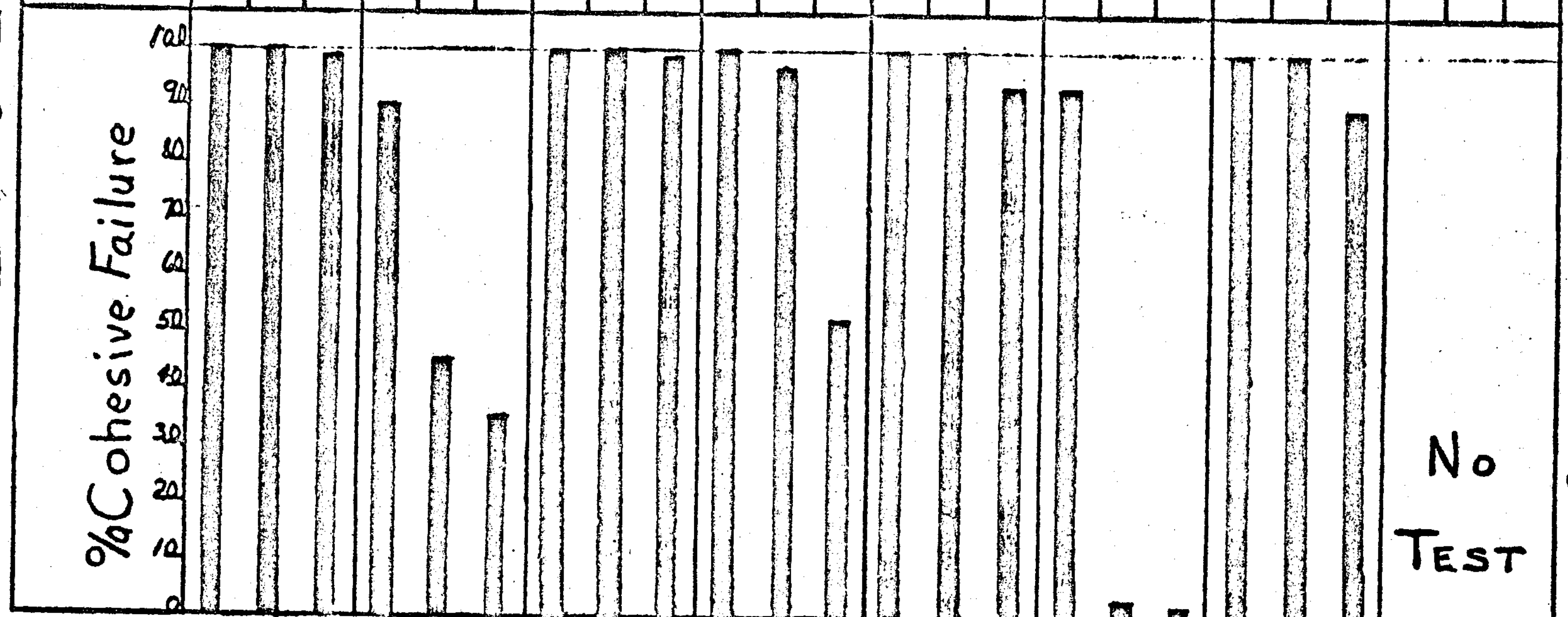
REVISED 6-9-61

12.0 Sealant Compatibility

REVISED 6-9-61

SEALANT COMPATIBILITY OF COATING AND
EFFECT OF CLEANER USED ON ADHESION OF SEALANT
(PEEL - BACK TEST)

Coating	BMS 10-11 PLUS LP-8 SWE42APT+V66KP16						ENMAR Epoxy-Thiokol 54-36231+T5301						ANDREW BROWN						BMS 10-11 unmodified					
Sealant	890			1422			890			1422			890			1422			890			1422		
Cleaner	0	3-2	11-7	0	3-2	11-7	0	3-2	11-7	0	3-2	11-7	0	3-2	11-7	0	3-2	11-7	0	3-2	11-7	0	3-2	11-7



CLEANER LEGEND INDICATES TYPE OF CLEANING
0 - No CLEANING
3-2 - BMS 3-2
11-7 - BMS 11-7

TABLE II

ADDENDA B

D3-2398, LABORATORY INVESTIGATIONS OF CORROSION PROTECTION IN B-52G INTEGRAL FUEL TANKS

ABSTRACT:

Studies of integral fuel tank corrosion protection systems for aluminum show that the combination of alkaline etch treatment, Iridite or Alodine chemical finish and a Buna N topcoating used on the B-52G from Unit 204 and on is satisfactory for adequate control of corrosion in integral fuel tank environment. These studies also conclude that Iridite or Alodine chemical finish on aluminum is not adequate to control corrosion in integral fuel tanks without the additional protection of an organic coating such as Buna N.

On early B-52G Airplanes, two types of corrosion have been observed on Iridite treated aluminum integral tank surfaces having no Buna coating. Studies of the observed corrosion indicate that its progression is slow and has not resulted in any significant loss of the metal properties after as much as one year of service. Further studies show that once corrosion has started, its progression is not significantly inhibited by JP-4 and therefore such corrosion may ultimatel affect the service life of the airplane.

Since there is no guaranteed analytical procedure which can predict the significance of existing corrosion on the ultimate service life of integral fuel tanks, it appears desirable that action should be taken to remove or inhibit such corrosion and provide an adequate corrosion protective system to prevent its reoccurrence.

REVISED

INTRODUCTION:

During the summer of 1958, early B-52G Airplanes on the flight line were observed to be subject to incipient white corrosion on aluminum surfaces within the integral fuel tanks that were not coated with Buna-N protective coating. The attack was first noted on the upper wing skins, stiffeners, and fuel vent covers. After several weeks of exposure to the weather on the flight line, the area subject to this attack had increased to include all non topcoated areas within the fuel tank, and was observed on wrought sheet as well as the milled wing skin. It should be pointed out that the white corrosion was so slight as to be discernible only with proper illumination, and careful examination.

In addition, black corrosion products were observed in isolated instances on milled surfaces that were also unprotected by the Buna-N coating.

Details of these two corrosion types are included in the following paragraphs.

REVISED

ADDENDA:

A. BAC Job Report F-2-140, Intergranular Corrosion of 7178-T6 Extrusions.

B. BAC Job Report F-2-144, Effect of Corrosion on Fatigue Properties of 7178-T6.

C. BAC Job Report F-2-145, Effect of Corrosion on Tensile Properties of 7178-T6.

D. BAC Job Report F-2-146, Studies of Integral Fuel Tank Corrosion.

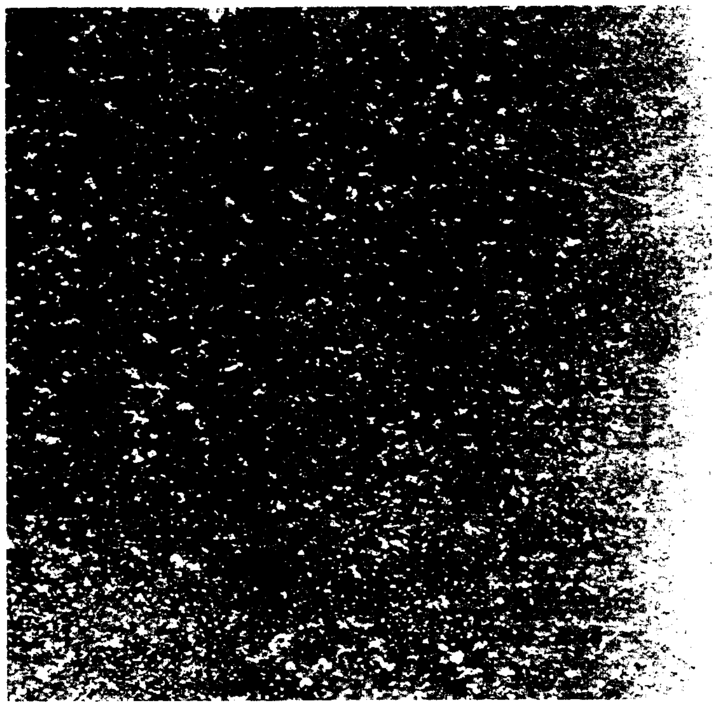
REVISED

CHARACTERISTICS OF CORROSION WITHIN INTEGRAL FUEL TANKS:

From numerous observations of integral fuel tanks both before and after flight operations, it has been established that two distinct types of corrosion exist. The first type, consisting of white tubercules, has been observed on all types of aluminum materials within the integral fuel tank. This white corrosion was observed first on the upper surfaces of wing tanks of planes exposed to weather on the flight line, but prior to the first fueling. The attack apparently starts by the formation of very minute puffs of white corrosion products which are a few thousandths of an inch in diameter. Each puff or tubercule consists of a roughly spherical deposit of corrosion products. The puff contains a very minute amount of white powder lightly held together in a sponge-like mass. The puffs may be seen only when suitably illuminated by a beam of light directed almost parallel to the metal surface. The puff may be wiped off by the slightest touch. Because of the extremely small quantity of corrosion products present, attempts to secure a sample for analysis have been unsuccessful. After extended exposure periods, puffs have been noted which have developed to a diameter of approximately 1/16 inch.

To illustrate the appearance of the white corrosion products, a laboratory sample, exposed to the atmosphere until a similar attack had developed, was photographed. Although this is not actual wing tank corrosion, it is quite representative of that observed in the tanks examined.

REVISED



Met. Lab. 3105 5X

FIGURE 1. Photograph of white corrosion products on aluminum similar to that observed in integral fuel tanks.

BW-155643

REVISED

CHARACTERISTICS OF CORROSION WITHIN INTEGRAL FUEL TANKS: (Continued)

Observations of this corrosion phenomenon have indicated the following proposed mechanism: Minute pores probably exist in the chemical finish. Droplets of water condense on the surface, and dissolved substances such as carbon dioxide, oxygen, and surface salts render the water mildly corrosive. The water solution penetrates through the pores, and dissolves very small quantities of aluminum. As the water droplets evaporate as a result of the warming of the metal, a sponge-like deposit of the corrosion deposits remains. Repeated condensation cycling increases the quantity of white corrosion deposit present in the puffs.

It is obvious that such a corrosion mechanism would eventually result in pitting of the aluminum surface. In isolated instances, detectable shallow pits have been observed under white corrosion sites, but in most cases the attack has not progressed to a point where pitting is evident.

Re-finishing of white corroded areas has been accomplished by the removal of the corrosion products, thorough cleaning, and re-application of the chemical treatment. This treatment has been observed to be only partially effective and supporting laboratory data shows conclusive evidence that an organic protective coating must be applied for adequate corrosion control.

A second, or black type, of corrosion occurs more commonly on milled surfaces which have not been etch cleaned. It appears to be the result of surface contamination, principally perspiration. Where a milled and chemically treated surface is contaminated, corrosion develops in the milling grooves, giving an effect similar to finger printing. Definite finger prints and hand prints

REVISED

CHARACTERISTICS OF CORROSION WITHIN INTEGRAL FUEL TANKS: (Continued)

have been observed, and in many instances significant areas have been corroded by contact with a moist forearm. The black corrosion attack starts in the milling cutter marks and has a tendency to progress longitudinally along the grooves.

Black corrosion can develop within a few hours after contamination, especially in hot summer weather.

Black corrosion products have been removed by the use of fine abrasive paper, after which the surface is cleaned and chemical treated.

In order to determine the significance of the corrosion observed in integral fuel tanks, a program involving several phases of study was initiated by the Protective Finish Group of the Materials and Process Unit. The individual reports of these laboratory studies are presented in the Addenda. The results of all study phases are summarized in the following conclusions.

REVISED

CONCLUSIONS:

MIL-C-5541, chemical finish on aluminum surfaces is insufficient to prevent corrosion within integral fuel tanks.

Alkaline etch cleaning of aluminum surfaces prior to chemical finishing significantly improves the corrosion resistance in integral fuel tank environment.

Organic protective coating significantly improves the corrosion resistance of existing tanks.

Alkaline etch cleaning of milled surfaces is essential in securing the maximum protection from chemical finish and organic protective coating.

Existing integral fuel tank corrosion is not inhibited by the presence of fuel.

Effort should be directed towards securing the most effective organic protective coating, particularly with regard to water resistance.

The 7178-T6 extruded wing skin material used in integral fuel tanks is not abnormally susceptible to intergranular corrosion.

The tensile properties of 7178-T6 extrusion are not measurably changed by surface corrosion in excess of that noted in B-52G integral fuel tanks.

Tests indicate that the fatigue properties of 7178-T6 extrusion may be affected to a small degree by corrosion in excess of that noted in B-52G integral fuel tanks.

RECOMMENDATIONS:

From the sum of the results of these studies, it is recommended that the following minimum finish be applied to integral fuel tanks:

Alkaline etch clean per BAC 3-6002 all machined aluminum parts.

Apply MIL-C-5541 chemical finish (BAC 5719 or BAC 3-6000), or chromic acid anodize per MIL-A-8625 (BAC 5019, to all aluminum parts.

Apply organic corrosion protective coating to all surfaces exposed within the integral fuel tank, including faying surfaces.

ADDENDA C

D3-2434, B-52G INTEGRAL WING TEST CUBE EVALUATION

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

REVISED

SUMMARY

In order to evaluate the structural design and the sealing methods and materials in the B-52G advanced (integral) wing, a test program was initiated early in 1956. This program consisted of the design, fabrication, sealing, and environmental testing of two small identical test cubicles representing a corner of the integral wing fuel tanks. One cube was sealed with the presently used integral fuel tank sealant (BMS 5-19) and the other cube was sealed with a new fuel resistant BMS 5-26 sealant (PR 1422). The cubes were subjected to identical cyclic, slosh and vibration, and load testing under realistic environmental conditions. Examination of the two cubes after testing revealed no apparent leakage or damage to the sealant or structure. The two cubes appeared to be equal in ability to withstand the test conditions to which they were exposed.

BMS 5-26 (PR 1422) Sealant has subsequently been used to seal the integral fuel tanks of the B-52G wing, with very satisfactory performance to date. The excessive slump (flow) and short work-life of BMS 5-26 Sealant (first observed herein) later caused serious production problems which led to the use of a different type mixer (Semco Rotary) to reduce slump and obtain a satisfactory work-life. As indicated by the four fastener leaks found after sealing the cubes, the greatest potential leakage source in the integral wing would appear to be leaking fasteners. Experience to date has shown that this is true--NACA rivet leaks have led to the extensive use of faying surface seals and the sealing of many fasteners which were supposedly self-sealing.

REVISED

INTRODUCTION

The two major objectives of this test cube program were: (1) the evaluation and comparison of sealing compounds and methods, and (2) the evaluation of the structural design of the test cubes - in particular the proposed tank end rib construction (wing station 492). In addition to the above, a test was conducted to investigate the hot air blower method to accelerate the curing of sealant in one of the test cubes.

The test cube program was a joint undertaking of the B-52G Project Structures Group, Engineering Experimental Shop, Process Staff Sealants Group, Power Plant Staff, and the Structural Test Unit. The program was conducted in the following phases:

<u>Phase I</u> - Design and Fabrication of the Test Cubes (B-52 Project Structures Group and Engineering Experimental Shop)

<u>Phase II</u> - Testing and Evaluation of New Sealing Compounds (Process Staff Sealants Group)

<u>Phase III</u> - Sealing the Cubes (Process Staff Sealants Group)

<u>Phase IV</u> - Accelerated Cure Investigation (Process Staff Sealants Group)

<u>Phase V</u> - Leak Testing of the Sealed Cubes (Power Plant Staff and Process Staff Sealants Group)

<u>Phase VI</u> - Environmental Testing of the Cubes (Power Plant Staff and Structural Test Unit)

REFERENCES

A. BAC Drawing 35-1717 "Wing Station 492 Rib Cubical-Test".

B. BAC Drawing 35-1840, "Sealing Application Wing Station 492 Rib Cubical-Test".

C. MIL-S-8802, "Sealing Compound; High Temperature Resistant For Integral Fuel Tanks and Fuel Cell Cavities".

D. Wichita Process Staff Lab Report No. S2-206, "Evaluation of Various Materials to MIL-S-8802".

E. Power Plant Staff Test Reports No. 213-1, -2, -3, "Wing Station 492 Tank End Rib Evaluation".

F. Structural Test Unit Test Report No. ST-S7-21, "B-52 Tank End Rib Test Cube", dated 17 October 1957.

G. BAC 5504, "Integral Fuel Tank Structure Sealing".

H. BMS 5-19, "Integral Fuel Tank Sealant".

I. S-2-253, "Leak Detection In Integral Fuel Tanks".

PROCEDURE

Phase I: Design and Fabrication of Test Cubes

Drawings for the fabrication and sealing of the test cubes (references A and B) were prepared by B-52 Project Structures Group. Two identical cubes were fabricated by Engineering Experimental Shop. The cubes represented the upper and lower wing surfaces, spar construction, and the proposed tank end rib construction, Wing Station 492. Seven photographs, listed in Table of Contents, show several views of the cubes during various stages of completion.

Phase II: Testing for new Sealants

New sealants have been developed which may exceed the physical properties of BMS 5-19; consequently, a screening program was initiated by the Process Staff Sealants Group to determine which of these new sealants would be most suitable for sealing the integral wing. Nine new sealants were tested to the qualification tests of MIL-S-8802 (reference C). Complete results of these tests were reported in reference D. No compound tested passed all the tests under MIL-S-8802; however, Products Research Company PR-1422 appeared to be the most promising and was subsequently used to seal one of the test cubes.

Phase III: Sealing the Cubes

In order that a comparison of the two sealing methods and compounds could be made, one cube (No. 1) was sealed per BAC 5504 using BMS 5-19 sealants, and the second cube (No. 2) was sealed with the new PR-1422 compound, using no

REVISED

Phase III: Sealing the Cubes (Continued)

precoat or topcoat. Photographs of the applied sealant are listed in the Table of Contents.

Sub-Assembly sealing was done during fabrication of the cubes by Process Staff personnel who were responsible for all sealing of the two cubes. Sealant materials were applied per reference B. All mating surfaces were coated with EC776R for corrosion protection, except for areas where faying surface isolation seals were called out.

Cube No. 1 was sealed per BAC 5504 with BMS 5-19, Types A-2 and B-2 sealants (PR-9021). The cube was topcoated with EC-1527 (sprayed) and a small amount of EC776R (brushed). Type A-2 sealant was hand mixed in small quantities (1.5 ounces) and applied immediately. It was found that approximately 1.5 ounces was the maximum amount that could be applied by one person before the material became too viscous to apply properly. Type B-2 sealant was mixed on a Semco Modes SP-1350 Mixer at 60 cycles and approximately 80 psi air pressure. Mixed sealant was stored at -40°F. (not over 10 days). Cartridges were thawed to near room temperature in warm water at 130°F. It was found that approximately 5 ounces of this material was the maximum that could be applied before the application time expired. The sealant was cured at room temperature for approximately 7 days before being tested for leaks.

Cube No. 2 was sealed with Products Research Company PR-1422, except for a small amount of Churchill 3C-3007. In general, these sealants were applied

Phase III: Sealing the Cubes (Continued)

per BAC 5504, except no precoat or topcoat was required. On most vertical or overhead applications it was necessary to apply the PR-1422 in several applications due to the excessive flow or slump of this material. Sealant was allowed to partially cure before the next application was made. It was initially intended that PR-1422 would be machine mixed but it was found that machine mixed PR-1422 flowed or slumped more than hand mixed PR-1422; consequently, all PR-1422 was hand mixed in small amounts of approximately 2 ounces and used immediately. This material had an extremely short work life (about 30 minutes) and it was found that no more than 2 ounces could be applied by one person before the material became stiff and unworkable. Metal seal caps were not available at the time this cube was sealed; therefore plastic caps were used on fasteners requiring sealing and were removed after sealant has cured. Sealant was cured at room temperature for approximately 7 days before being tested for leaks.

During the sealing of cube No. 1, considerable information on the application times and quantities of each compound used was recorded. This information is tabulated in Table I. From this table it can be seen that 87 man-hours were required for the application of 13.7 pounds of material.

In general, the sealing of these cubes was very difficult. The close quarters and structural designs made some of the normal application techniques impossible. Lighting was frequently inadequate and in many areas it was necessary to use mirrors to see where to apply and work the sealant. The following comments were

Phase III: Sealing the Cubes (Continued)

made by personnel who sealed the cubes and are of interest as they present some of the problems that will need to be resolved to insure proper sealant application:

"a. Great difficulty was encountered in applying fillets between the upper fuel dams and rib chords as this area is out of direct line of vision and mirrors must be used. Allowing the upper fuel dams to extend out beyond rib chords would eliminate this problem.

b. Fillets around fuel dams must be faired by holding the fairing tool at right angles to the fillet rather than parallel to the fillet due to close quarters.

c. Some injection holes were too small to allow passage of sealant. Some were of such dimensions (long and narrow) as to allow excessive sealant backflow. Injection holes should be large enough to receive nozzle, but small enough to prevent excessive backflow of sealant.

d. Fillet dimensions are such that some fillets overlap rivets making fairing of fillets difficult. Should any of these rivets leak and require re-striking, damage to the adjacent fillet may result.

e. Some method should be provided for attaching mirrors and portable lights to structure, thus leaving both hands free for sealing. Suction cups could possibly be used.

f. Semco nozzles with greater angles in them (90°) were needed for applications to some areas.

REVISED

Phase III: Sealing the Cubes (Continued)

g. Some AN bolts in fuel dams were too close together and too close to the radius of structure to allow proper application of seal caps to these bolts. Some of these bolts were out of line of vision and properly fairing sealant around bottom of seal caps on these bolts was very difficult.

h. Application of PR-1422 to vertical or overhead areas was difficult due to excessive flow or slump of this compound. It was necessary to build up the full bodied fillets in these areas in several applications, allowing time between each application for the sealant to become tack-free."

Phase IV: Accelerated Cure Test

Tests were conducted to determine if hot air blowers could be used for accelerating the curing rate of sealant in structure similar to the integral wing. This test was performed in one of the test cubes, the main purpose being to measure the temperature variations throughout the cube when hot air was fed into one opening.

Air at approximately 140°F. was fed in through a flexible duct and the temperature at various surfaces was measured by taping thermocouples to these surfaces within the cube. The stabilized temperatures in this case varied from 102 - 130°F. Air was then fed in at approximately 160°F. and an attempt was made to baffle the air into the cube to obtain more uniform circulation. Temperatures

REVISED

Phase IV: Accelerated Cure Test (Continued)

were found to range from 110 - 129°F. These large temperature variations would not allow uniform curing; consequently, it was concluded that some type of insulation on the exterior surfaces would probably be necessary to minimize heat loss if this method of accelerated curing was used.

Phase V: Leak Testing of Sealed Cubes

Upon the completion of sealing and curing, each cube was leak tested by Power Plant and Process Sealants personnel. The following leak detection methods were used:

1. Ammonia - Boeing Leak Detection Paint, Type F
2. Ammonia - Phenolphthalein
3. General Electric Halogen Leak Detector
4. Dyed fuel
5. Differential pressure

It is not intended that this section should evaluate or compare the advantages of the above methods of leak detection. A report on leak detection has been written evaluating each method (Reference I.).

Table II tabulates the leaks found in each cube, location, method of detection, cause of leak, and steps taken to stop the leak. Of the 8 leaks found, 7 were due to fasteners and 1 was due to a cracked fuel dam.

Phase VI: Environmental Testing of Sealed Cubes

A. Aging of Sealant (reference F; 213-2, page 3)

Phase VI: Environmental Testing of Sealed Cubes

Both cubes were filled with modified JP-4 test fluid (ARTC W-83, Type B) of the following composition:

Toluene	30 volumes
Cyclohexane	60 "
Iso-octane	10 "
Tertiary butyl disulfide	1 "
Tertiary butyl mercaptan	0.015 weight percent

The cubes were heated to 130°F. for 24 hours at 3.5 psig. Pressure was then raised to 6.0 psig for 30 minutes. No loss in pressure was observed during this period. The cubes were then drained and heated to 160°F. for 48 hours at atmospheric pressure. Then 6 psig pressure was applied for 30 minutes and the cube was again found to be leak-free.

B. Cyclic Test (reference F, 213-2; page 3)

The cubes were filled with modified JP-4 test fluid and the temperature was reduced to -65°F. for 24 hours at atmospheric pressure. The cubes were examined and no leaks were observed. The cubes were then subjected to 1000 pressure cycles at -65°F., a pressure cycle being from + 6 psig to - 1.5 psig to + 6 psig. Actual pressures varied from 6 to 8 psig on the positive side and to 1.5 to 2.5 psig on the negative side. Time required for the 1000 cycles was approximately 14 hours. No fuel leakage was found on completion of these tests.

C. Slosh and Vibration Tests (reference F; 213-3, page 1)

The slosh and vibration tests were conducted with the two cubes filled two-thirds full of modified JP-4 test fluid circulating at -65°F. The vibration test was conducted simultaneously with the slosh test for the first 25 hours. The slosh test was then continued for an additional 15 hours.

REVISED

Phase VI: Environmental Testing of Sealed Cubes (Continued)

The two cubes were mounted in rigid steel support structures and fastened to the frame of the slosh and vibration table in such a manner that the representative spars were rotated 36 degrees to the axis of rotation. The cubes were vibrated for about three hours before the load distributions were adjusted to give the desired displacements. The average displacement for the 25 hours of vibration, taken four points on each cube, was 0.0353 inches at a frequency of 200 CPM. The slosh test was conducted for 40 hours under conditions of 10 to 16 CPM through a total angle of 30 degrees, 15 degrees each side of the horizontal. On completion of the test, the cubes were pressure tested at 6 psig for 20 minutes. There was no leakage. The cubes were opened and examination of the sealant revealed no damage.

D. Load Test (reference G)

The Structural Test Unit designed, fabricated, and installed the loading jig for the load cycling test, and assisted in completion of the tests. The test cubes were mounted in the loading jig in such a manner that the loading of 130,000 pounds was applied to both cubes simultaneously. The load on the lower surface was applied diagonally across the cube at 43° off the rib centerline. The load at the upper surface was applied at right angles to the load at the lower surface. AA-2 strain gauge rosettes for measuring panel stress were applied to cube No. 2. The gauges were applied back to back on the panels in pairs, 1 and 2, 3 and 4, etc. Loads were applied to the cubes by means of hydraulic rams. Tension load cells were used in conjunction with load cell indicators to indicate applied loads.

Phase VI: Environmental Testing of Sealed Cubes (Continued)

Another indicator was used to indicate induced stresses as measured by the strain guages on cube No. 2.

Three static tests were made on the cubes prior to the cycling test. Cubes were empty and at room temperature. In each case, the load was applied to 100% in 10% increments. In the first two tests, the load was decreased from 100% to 50% and then to 0%. In the third test, after 100% was reached, the load was decreased to 0% in 20% increments.

The cubes were then filled with modified JP-4 test fluid and cooled to -65°F. at 6 psig pressure by circulating the fluid through a tank containing dry ice. The cubes were then subjected to 1000 cycles, a cycle being from 0% to 100% to 0% (100% = 130,000 pound load). At the completion of the 1000 cycles, the cubes were warmed to a fluid temperature of 70°F. and a final static test at 6 psig was performed. The load was applied to 100% in 10% increments, then decreased to 50% and finally to 0%.

No leakage was observed during the load tests. Strain gauge readings were taken throughout the test. The maximum shear measured occurred on the top skin and reached a value of 8,500 psi. Stress results were negligible; consequently, no data is included in this report, although this data is available through the Structural Test Unit.

E. Final Pressure Testing

Upon completion of all tests the cubes were pressurized to + 9.5 psig for 30 minutes. There was no loss of pressure. A negative pressure of -2.5 psig was applied to both cubes for 30 minutes. There was no pressure change.

Phase VI: Environmental Testing of Sealed Cubes (Continued)

F. Performance Test Results

All of the above tests were successfully completed without any evidence of leakage in either cube.

RESULTS

A. New Sealants (Phase II)

Of the nine new sealing compounds tested under reference C, Products Research Company PR-1422 was found the most satisfactory. This sealant was used to seal test cube No. 2.

B. Sealing the Cubes (Phase III)

Application of PR-1422 was much more difficult than the application of BMS 5-19 due to excessive flow (or slump) and short work-life.

General sealing of the two cubes was difficult due to the close quarters and new structural design (tank end ribs). Some areas out of direct line of vision were extremely difficult to seal properly. Problems encountered are listed in Phase III.

C. Accelerated Cure Test (Phase IV)

Use of hot air blowers to accelerate the cure of sealant in the integral wing will probably require the use of some type of insulation on the exterior surfaces to obtain even temperature distribution, otherwise cold spots will result in uneven curing of sealant (see Phase IV).

D. Leak Testing of Sealed Cubes (Phase V)

Upon leak testing the sealed cubes, eight leaks were found (four in each cube). Leaks were due to four leaking fasteners and a crack in a fuel dam (see Table II).

E. Environmental Testing (Phase VI)

Upon completion of all environmental testing of the two cubes, they were pressure tested at + 9.5 psig and -2.5 psig. There was no leakage (reference E; 213-3, page 2).

The cubes were opened and examination revealed no damage to the sealant or structure. The two test cubes appeared to be equal in ability to withstand the environmental test conditions to which they were exposed.

REVISED

TABLE I

TYPE OF APPLICATION	MATERIAL USED	QUANTITY REQUIRED LB.	APPLICATION TIME HRS.
CLEANING	MIL-S-7502 SOLVENT		
UPPER 2/3			12.75
LOWER 1/3			8.50
			21.25
INJECTIONS	PR9021 TYPE B		
TOP		0.44	
BOTTOM		0.40	
		0.84	2.67
BRUSHCOATS	PR9021 TYPE A	1.07	14.75
FILLETS	PR9021 TYPE B		
PRIMARY		3.14	18.25
SECONDARY		3.73	15.17
FASTENERS		1.89	6.67
TOTALS		8.76	40.09
TOPCOAT	EC1527	2.60	3.09
	EC776-R	0.39	5.17
		2.99	8.26
TOTALS		13.66 LB. MATERIAL APPLIED	87.02 HRS. TOTAL TIME REQ'D

MATERIAL AND TIME REQUIRED
TO SEAL CUBE #1

REVISED

TABLE II

LEAKS FOUND IN SEALED CUBES (Before Environmental Tests)

CUBE NO.	NO. OF LEAKS	LOCATION OF LEAK ON OUTSIDE STRUCTURE	LEAK DETECTION METHOD	INSIDE SOURCE OF LEAK	ACTION TAKEN
1	4	R. H. side, lower R. H. corner between lower rib chord and rib web	Ammonia - Leak Detection Paint Ammonia - Phenolphthlein Halogen Detector	Huck bolt not sealed	All huck bolts were sealed
2	1	R. H. side, between top of "Z" stiffener and lower rib chord	Ammonia - Phenolphthalein Halogen Detector Dyed Fuel	Tack rivet on top lower (see illust. No. 1)	Tack rivet sealed
	1	L. H. side, between top of "Z" stiffener and lower rib chord	Ammonia - Phenolphthalein Halogen Detector Dyed Fuel	AN bolt leaked (see illust No.2)	AN bolt resealed (bolt out of direct line of vision and difficult to seal)
	1	L. H. side, between bottom of upper center fuel dam and rib chord	Halogen Detector	Small crack in fuel dam (see illust. No. 3)	Fillet applied over crack in dam
	1	L. H. side, between bottom of upper fuel dam and rib chord (second dam from RF)	Halogen Detector	NACA rivet in upper fuel dam leaked (see illust No. 4)	Rivet was sealed

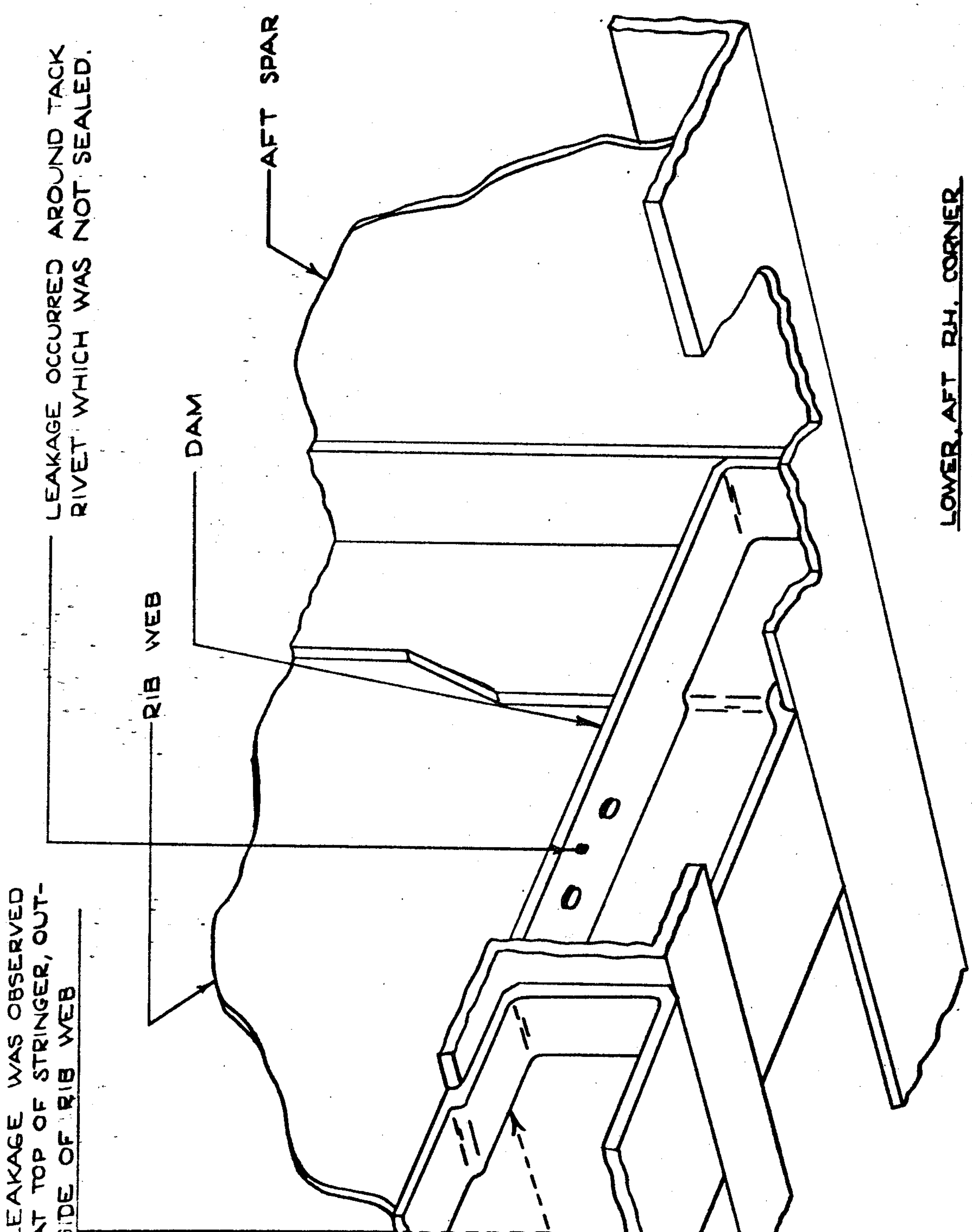


ILLUSTRATION NO. 1
TACK RIVET LEAK

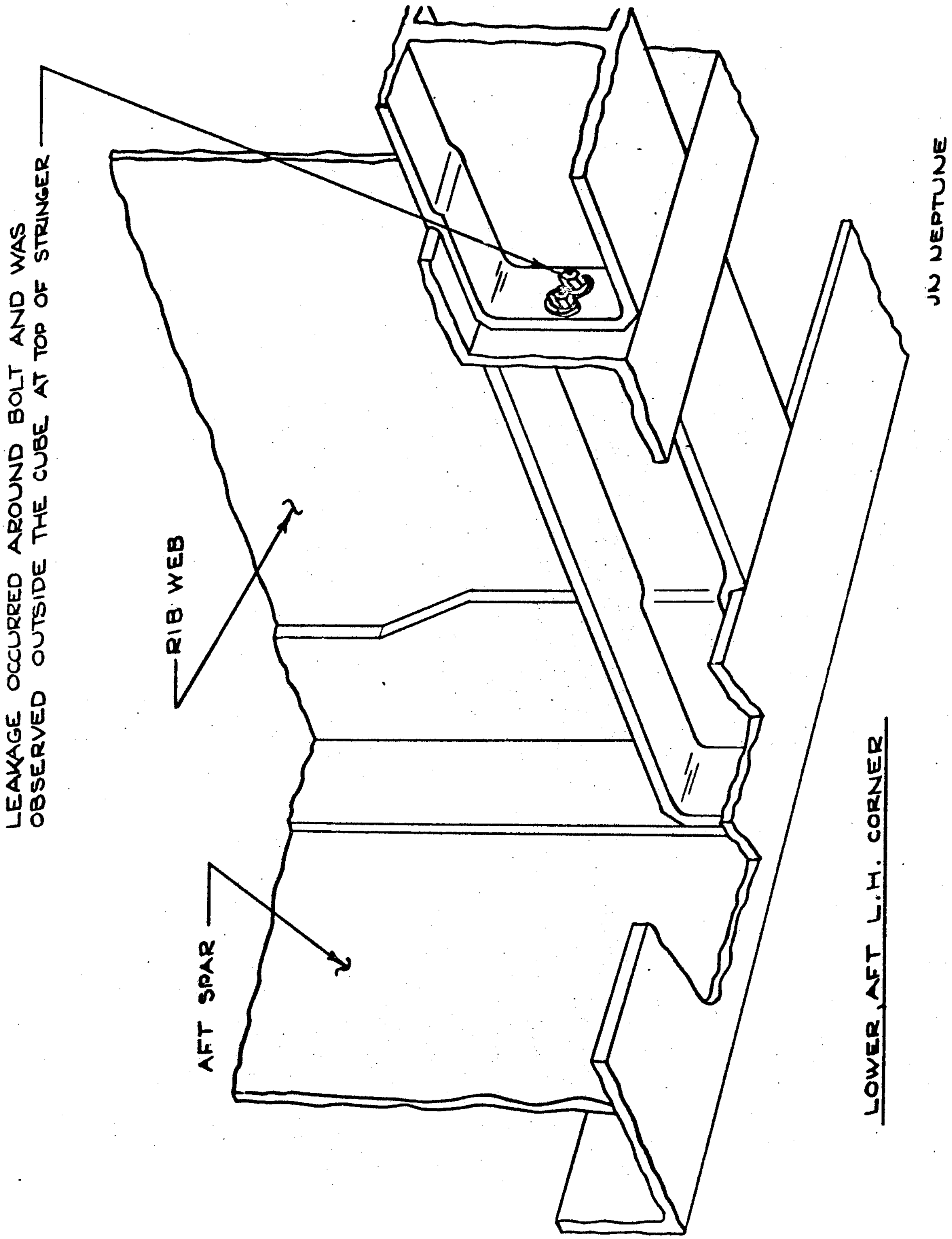
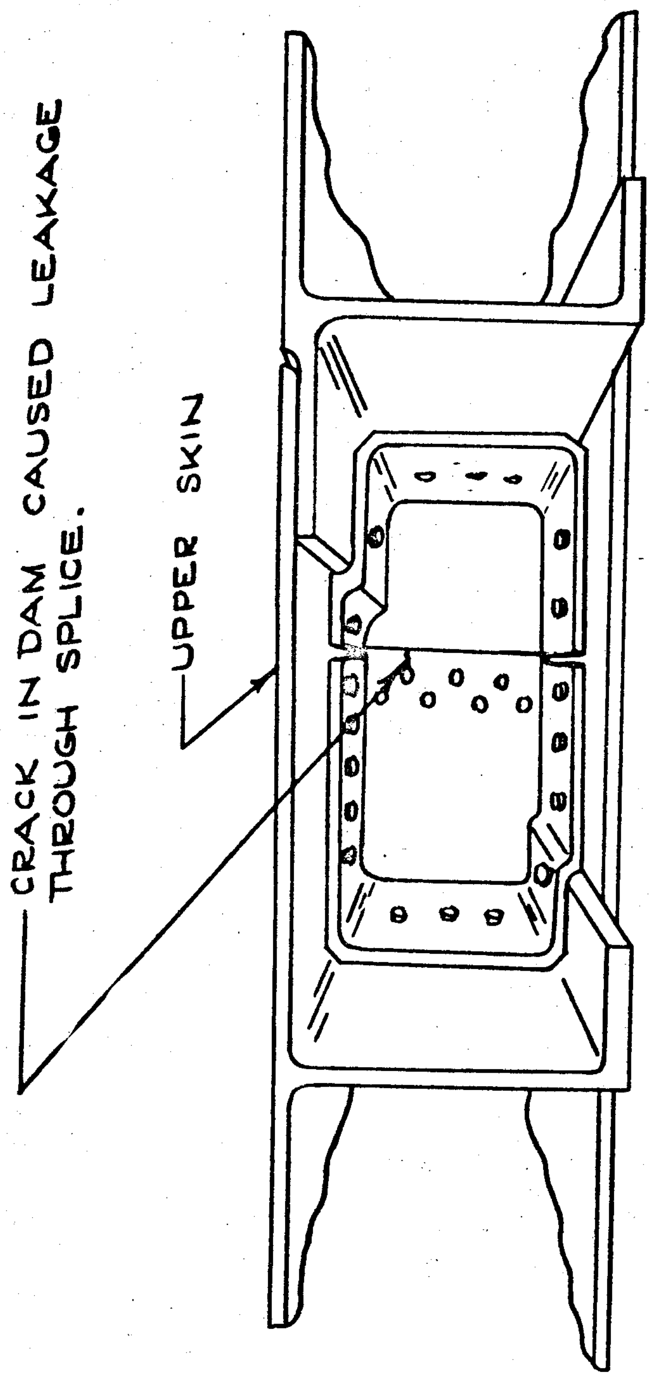


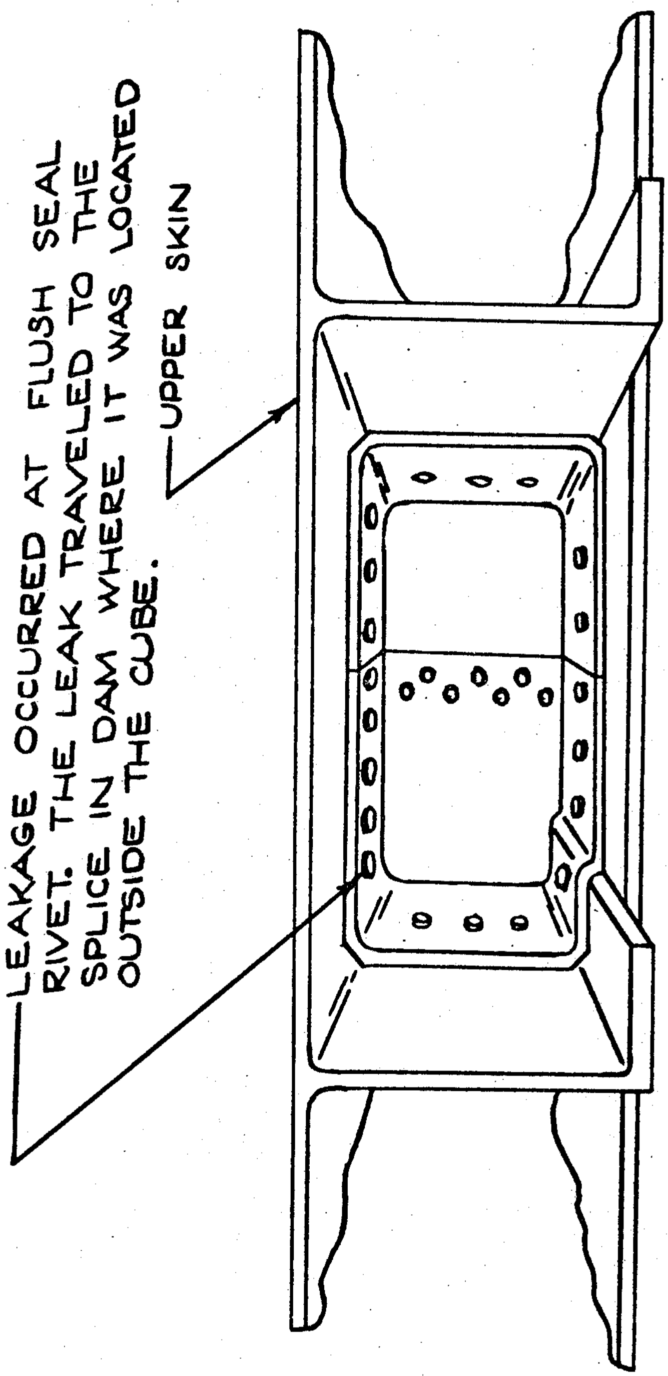
ILLUSTRATION NO. 2
AN BOLT LEAK

REVISED



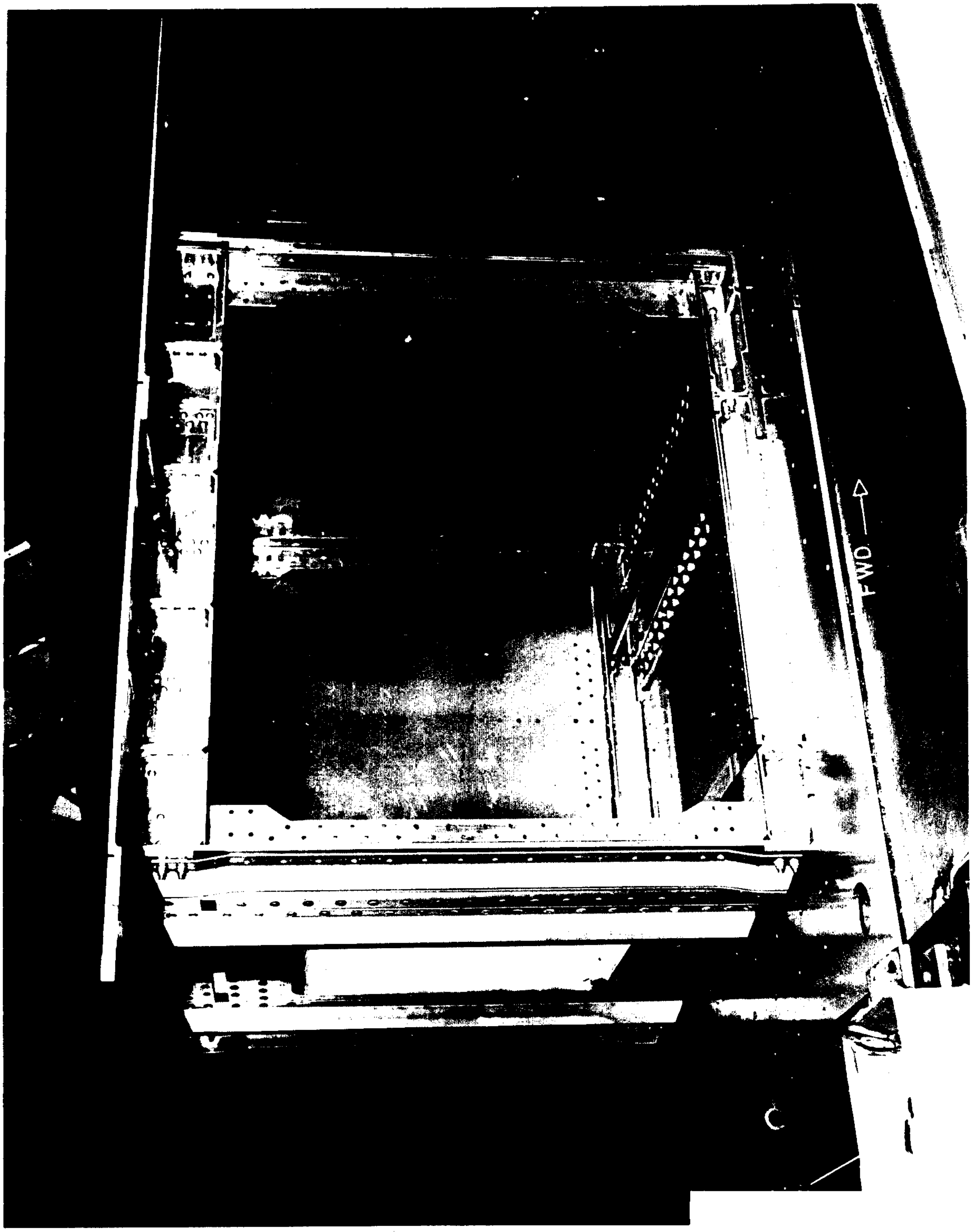
MIDDLE DAM UPPER L.H. SIDE

ILLUSTRATION NO. 3
CRACK IN FUEL DAM



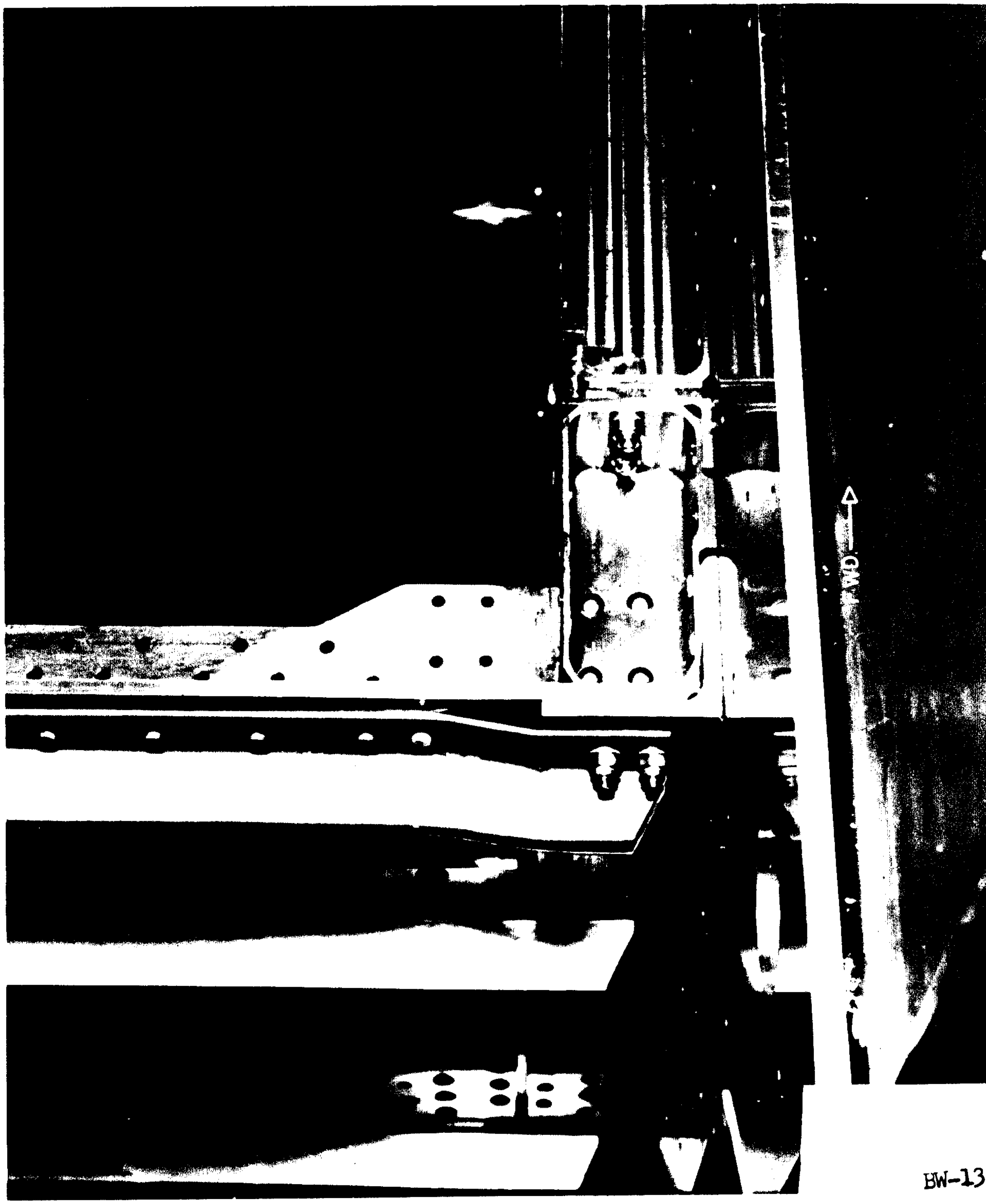
UPPER L.H. SIDE

ILLUSTRATION NO. 4
NACA RIVET LEAK



BW-132369

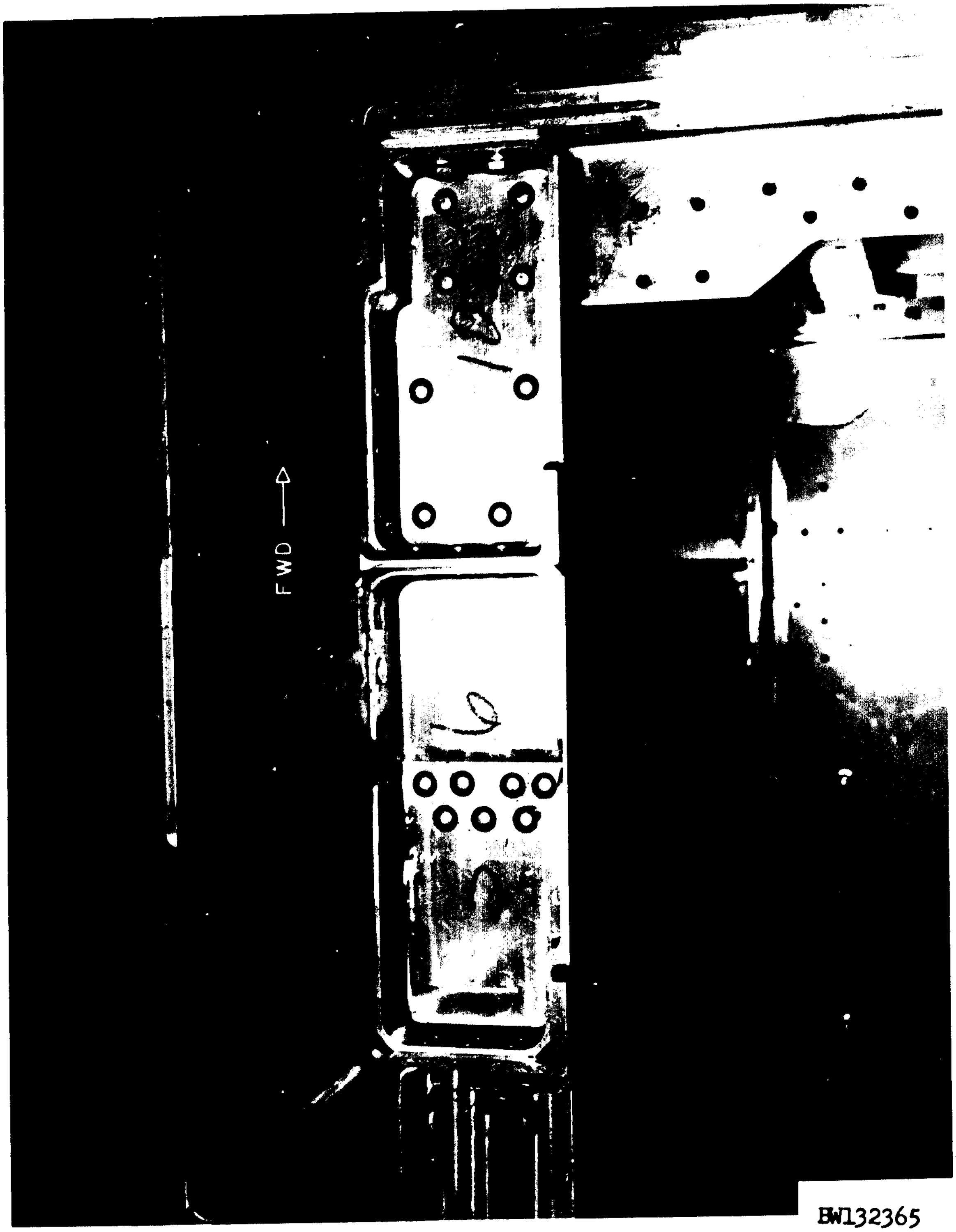
BW-157724



BW-132363

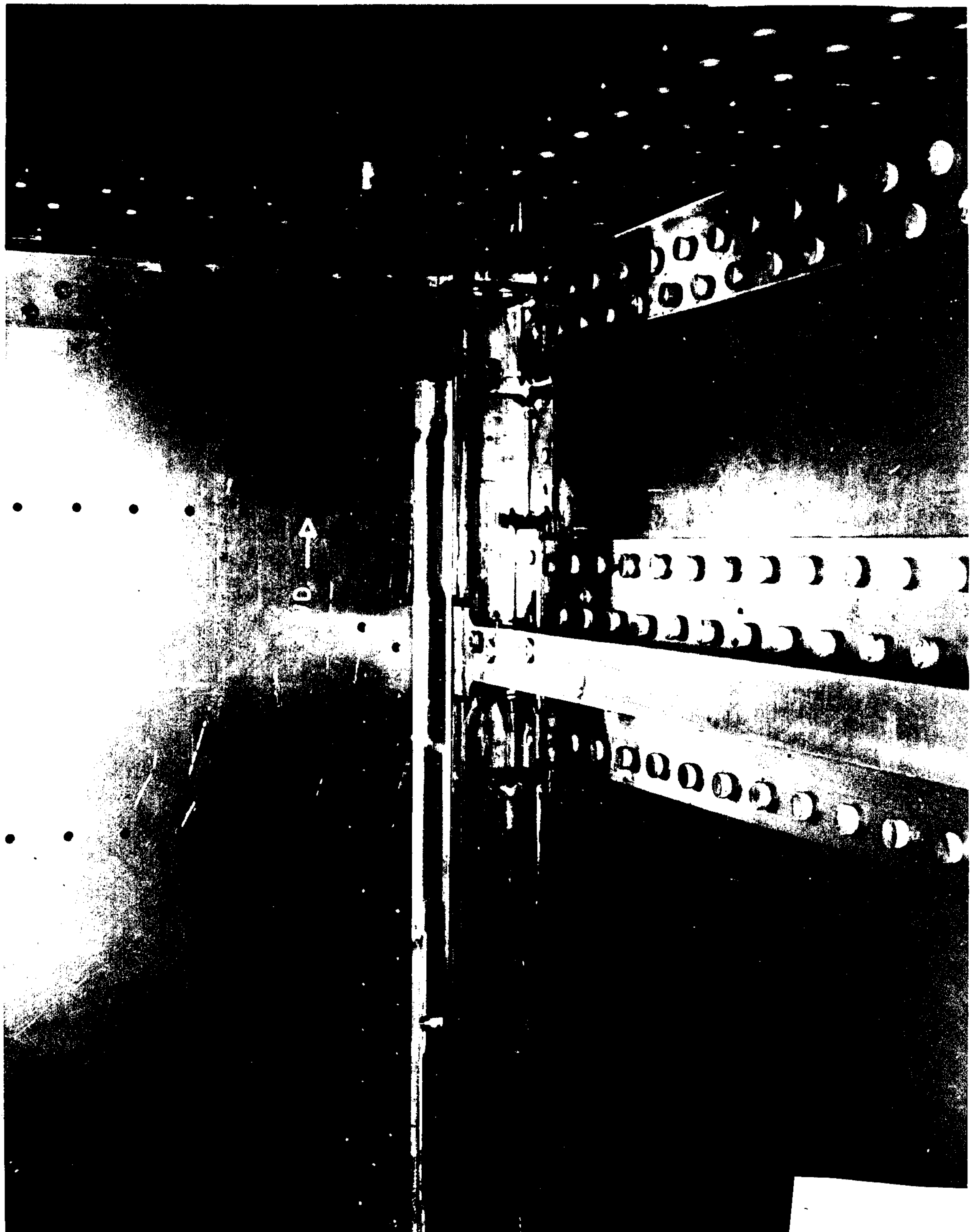
BW-157725

REVISED



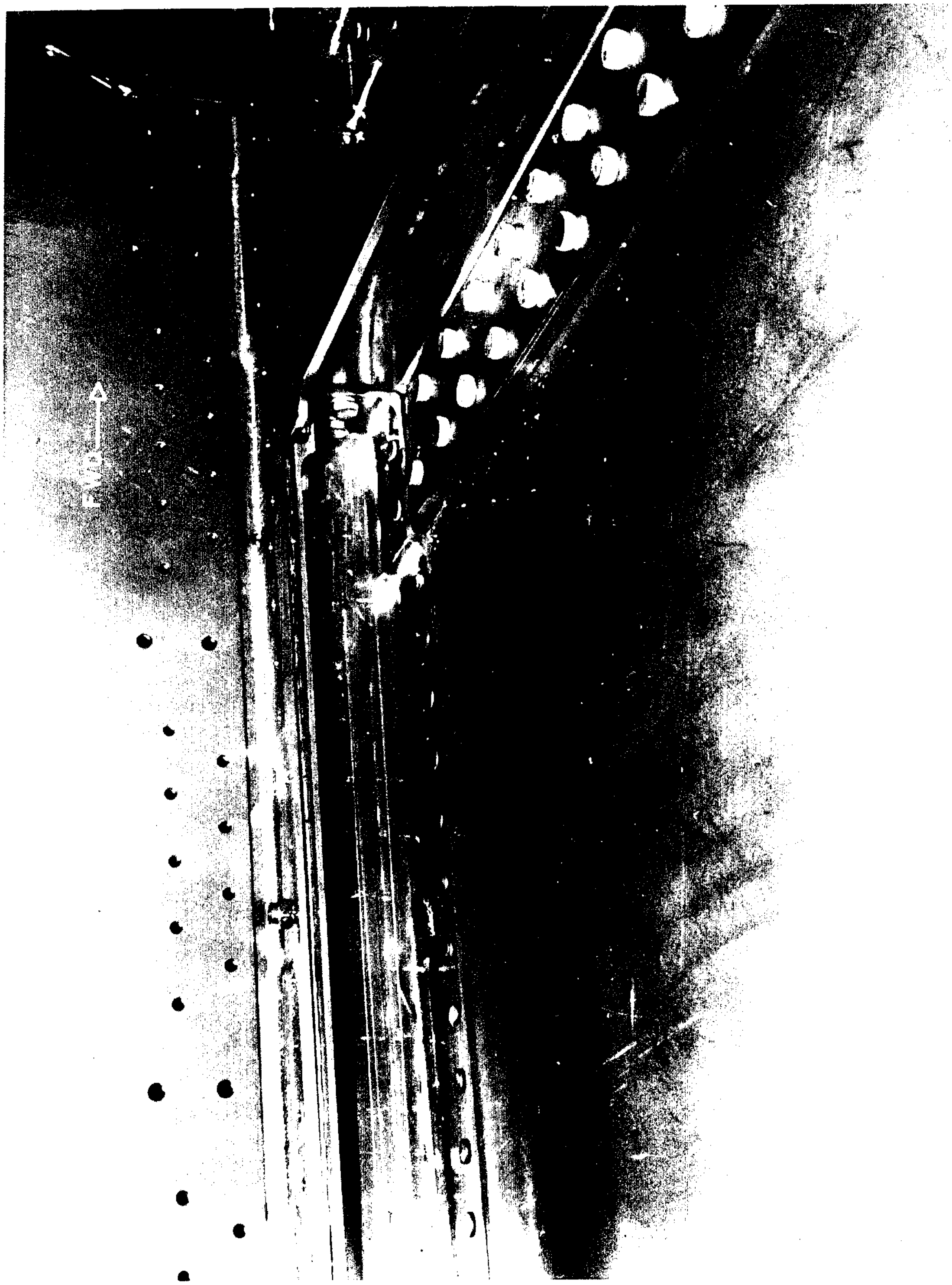
BW132365

BW-157726



BW-132362

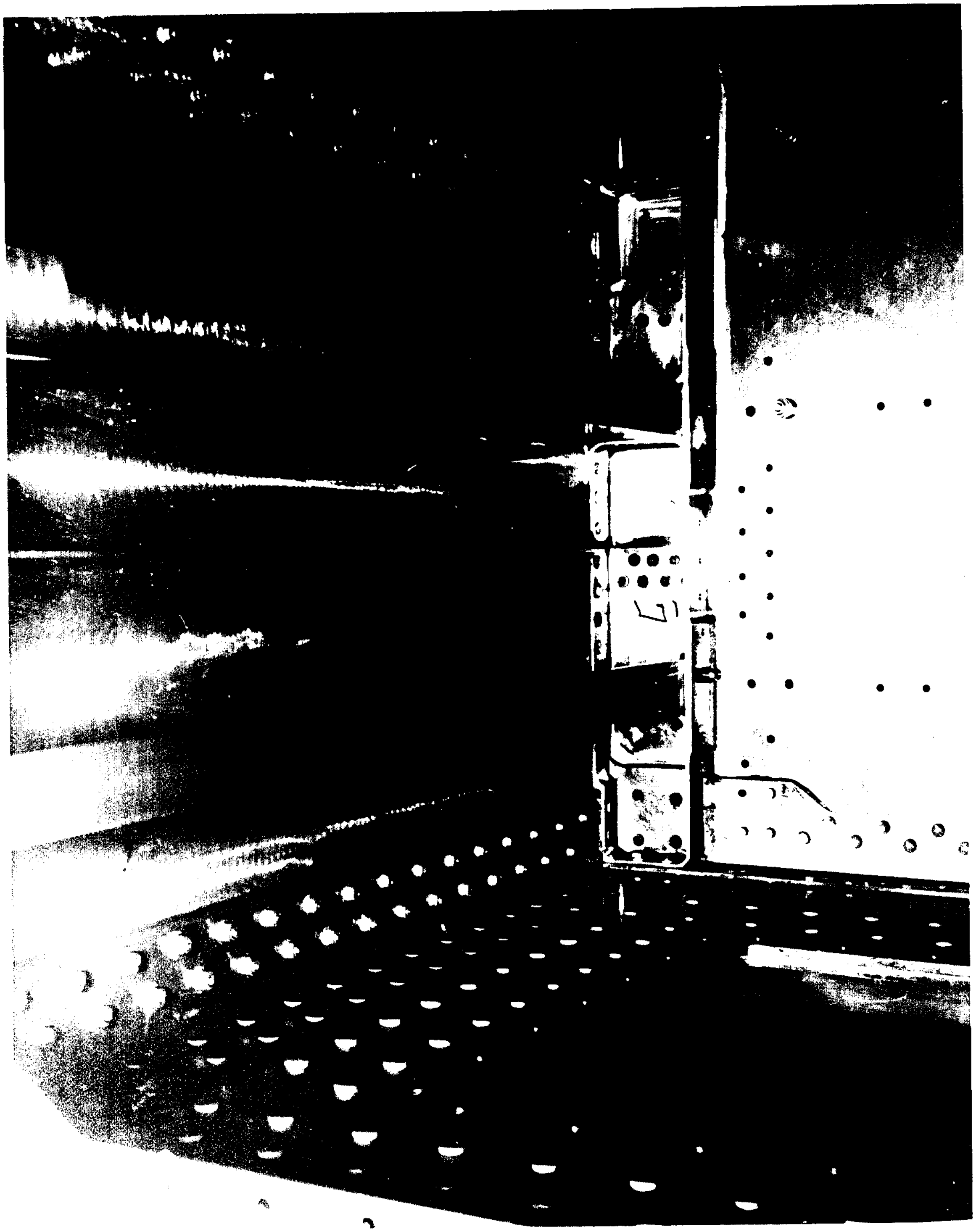
BW-157727



BW-132360

BW-157728

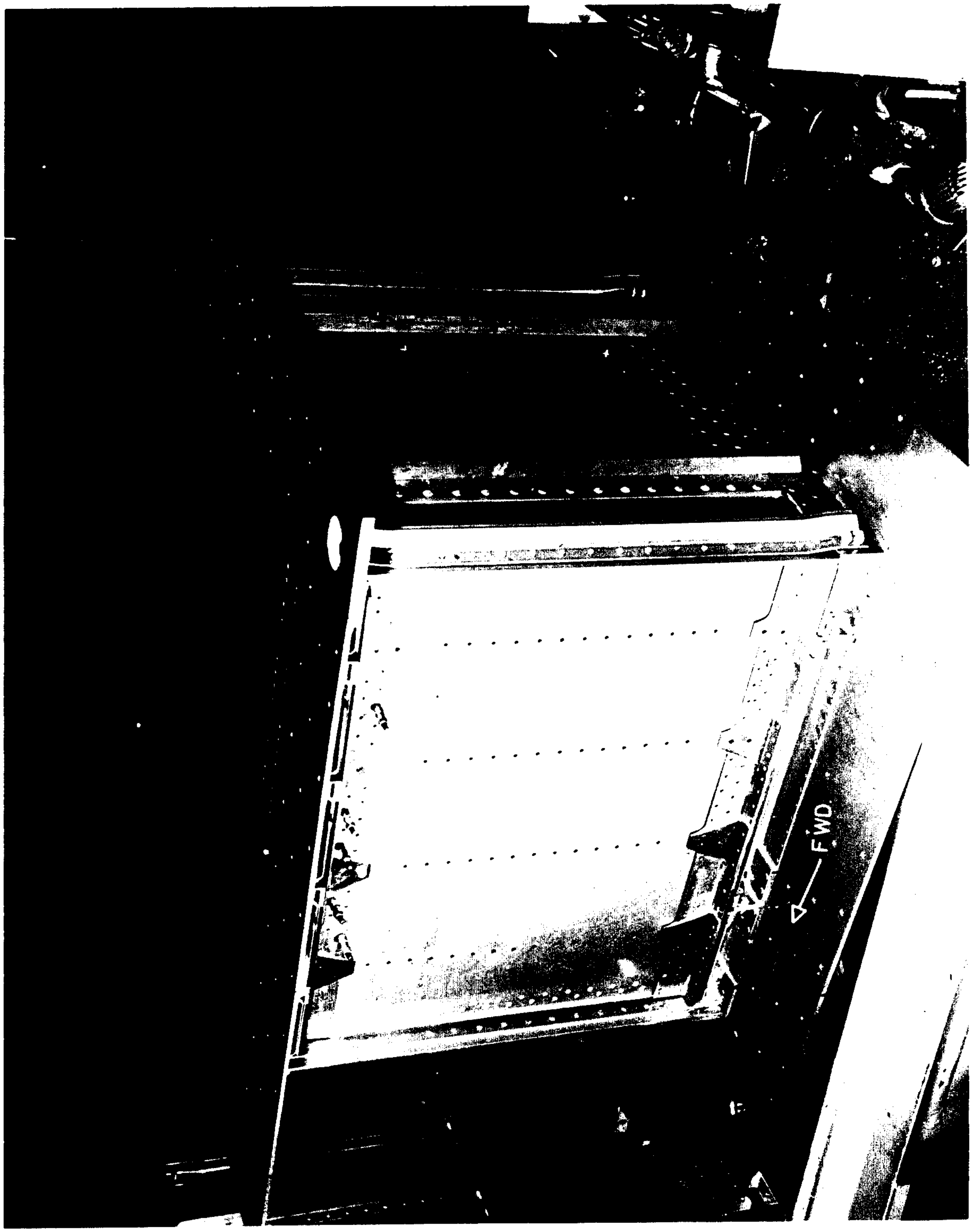
REVISED



BW-132366

BW-157729

REVISED



BW-132370

BW-157730

REVISED

BW-134346

TEST CUBE NO. 1
RT FWD CORNER

REVISED

BW-157731

BW-134348

TEST CUBE NO. 1
LEFT FWD CORNER

BW-157732

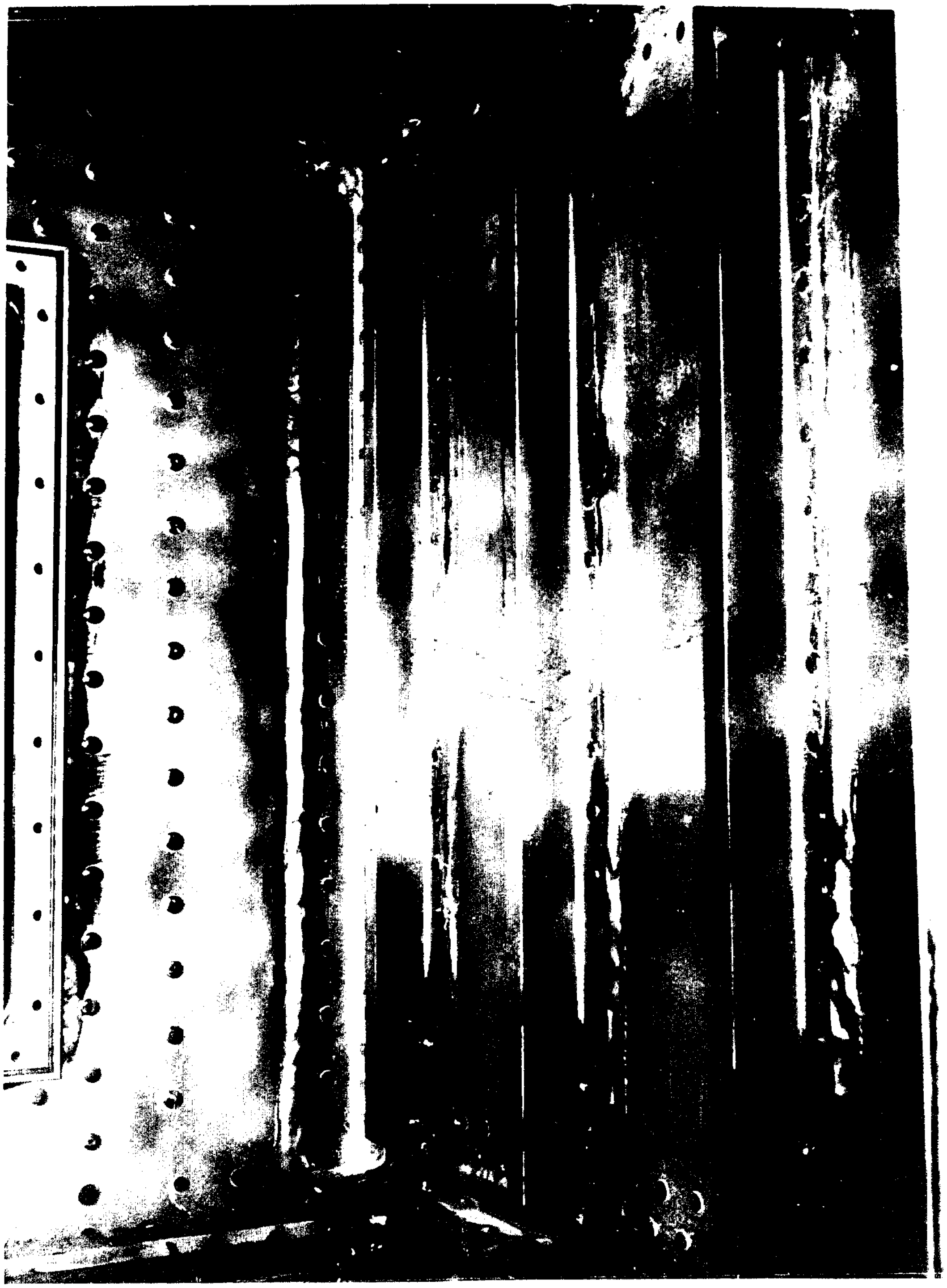
REVISED

TEST CUBE NO. 1
RT AFT CORNER

BW-134350

REVISED

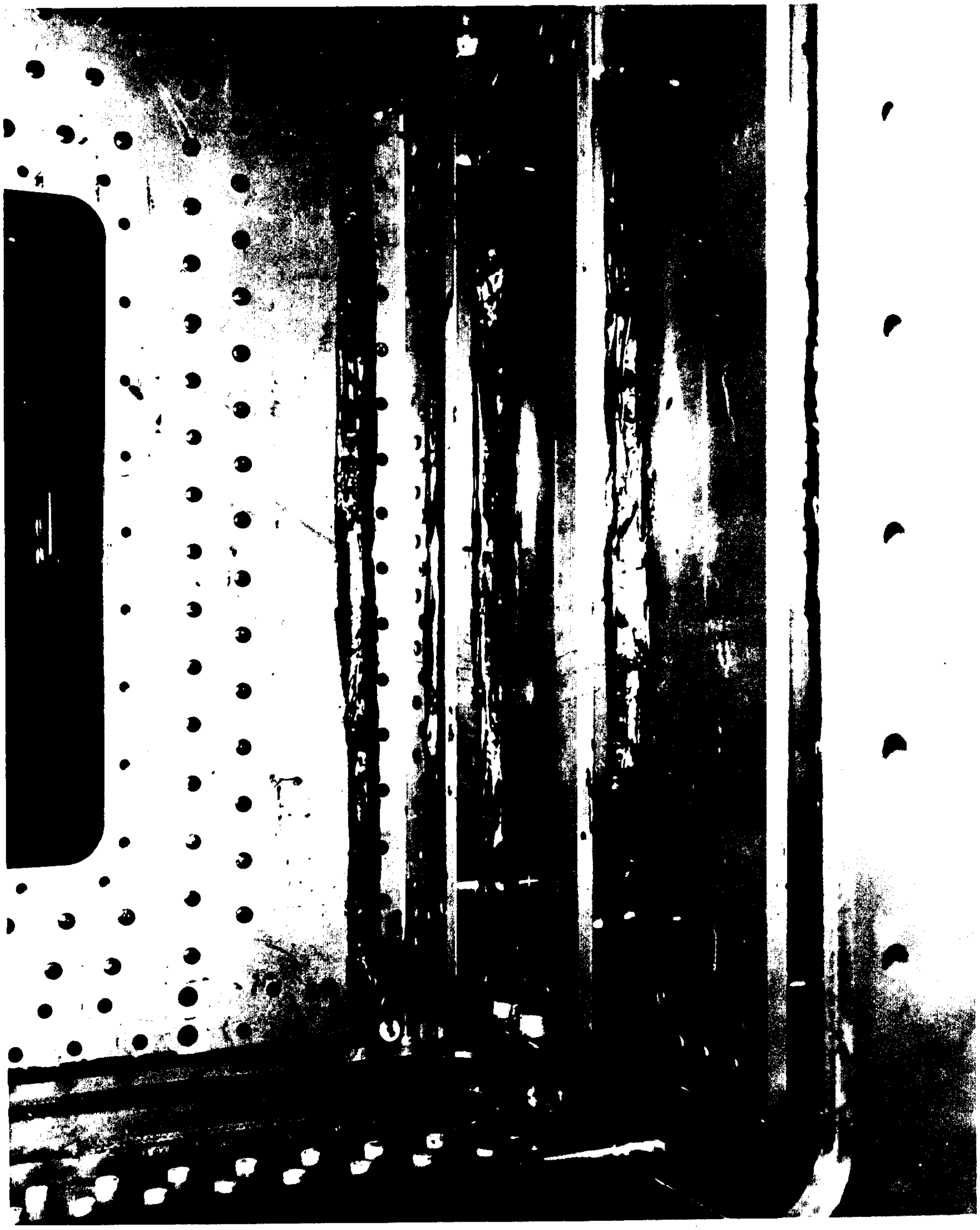
BW-157733



TEST CUBE NO. 1
LEFT AFT CORNER

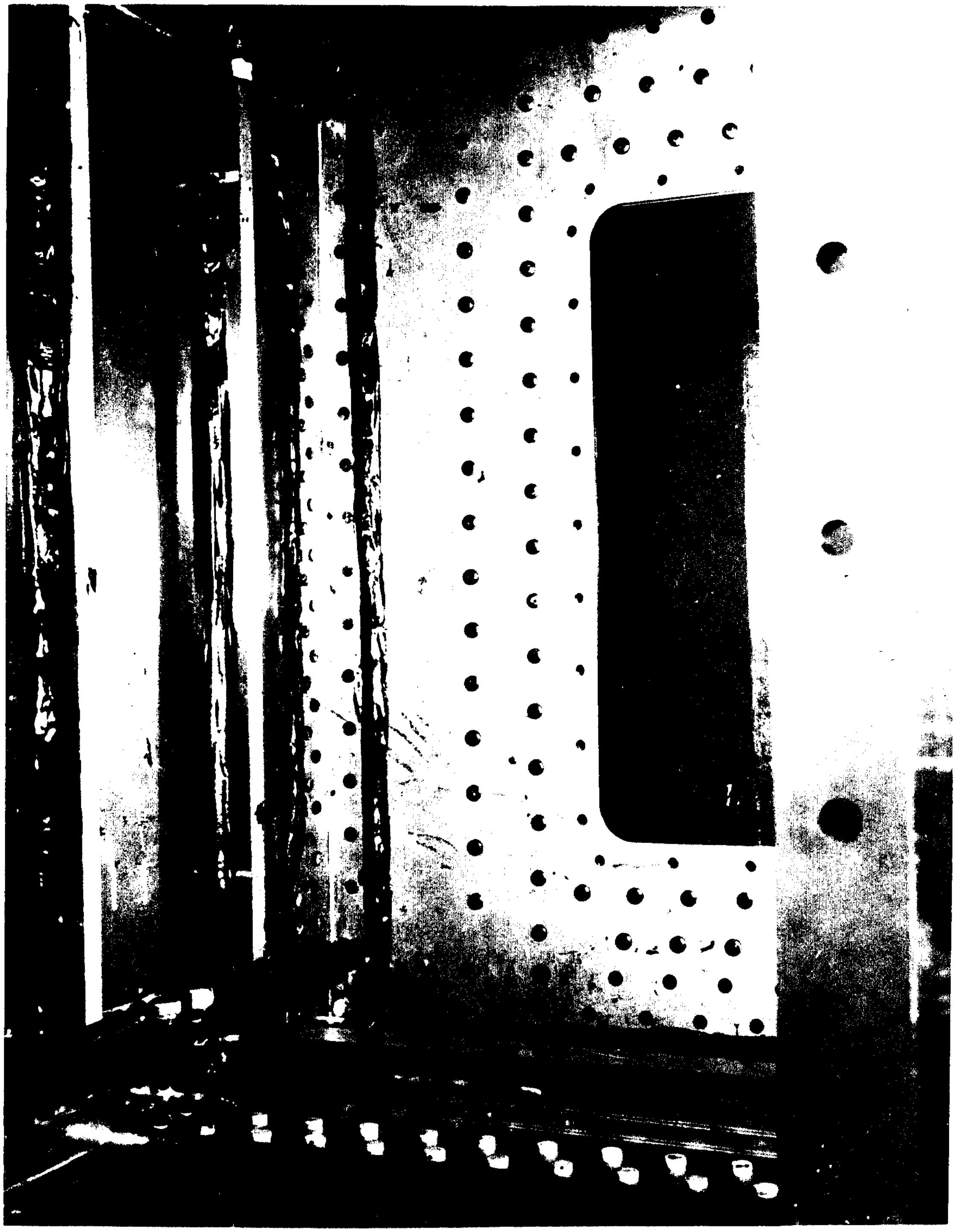
BW-134352

REVISED



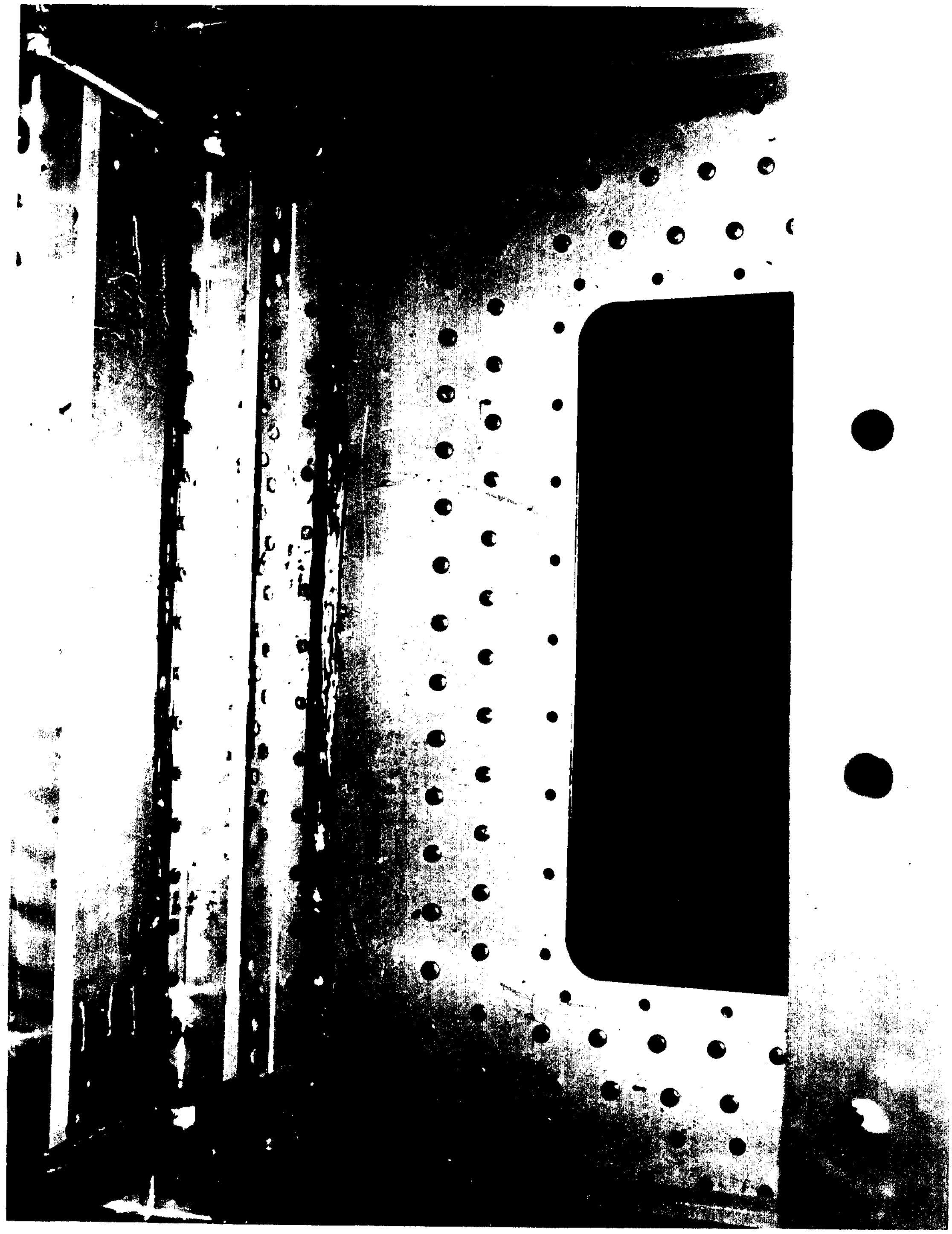
TEST CUBE NO. 2
FT FWD CORNER

BW-134347



TEST CUBE NO. 2
LEFT FWD CORNER

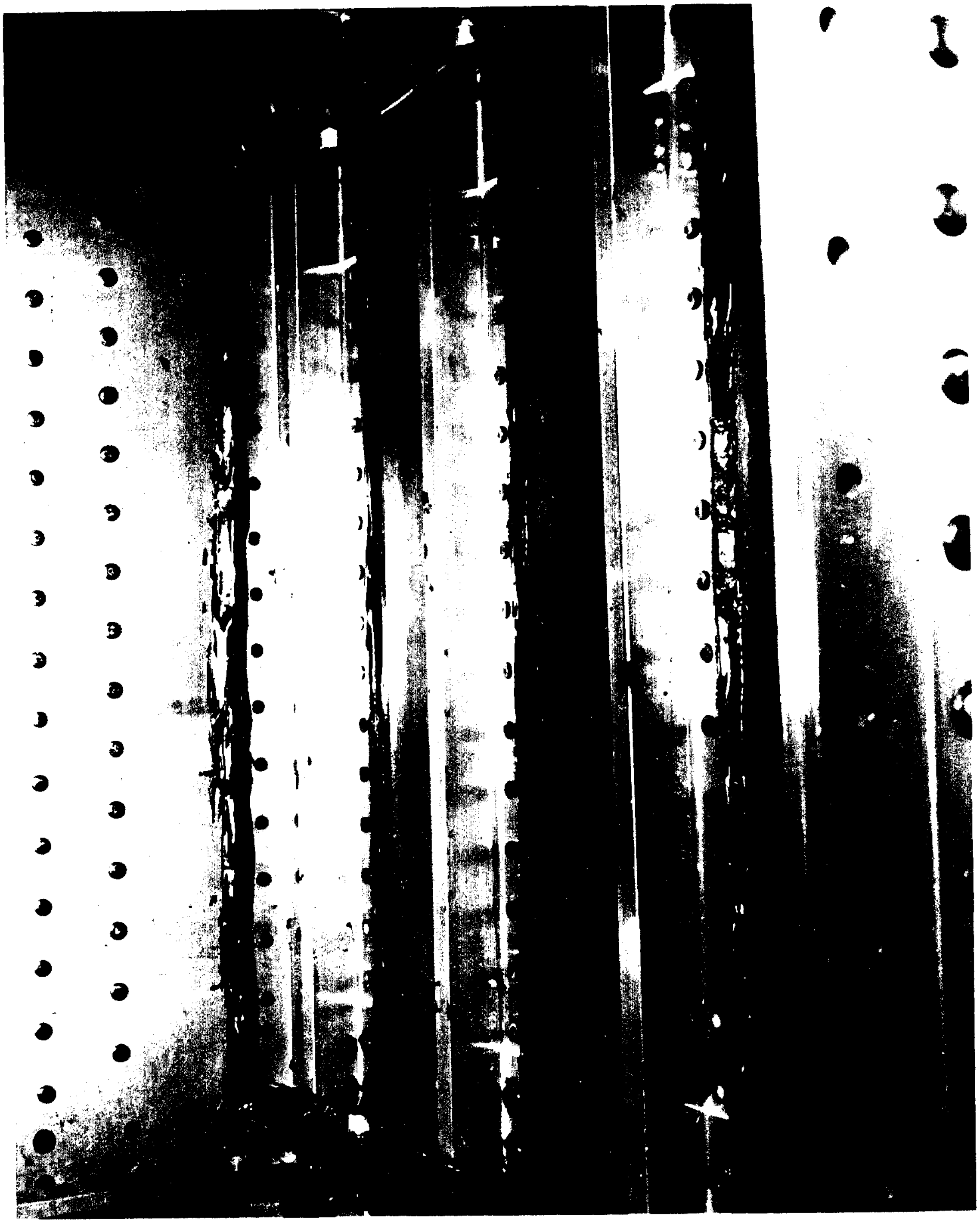
BW-134349



TEST CUBE NO. 2
RT AFT CORNER

BW-134351

BW-157737

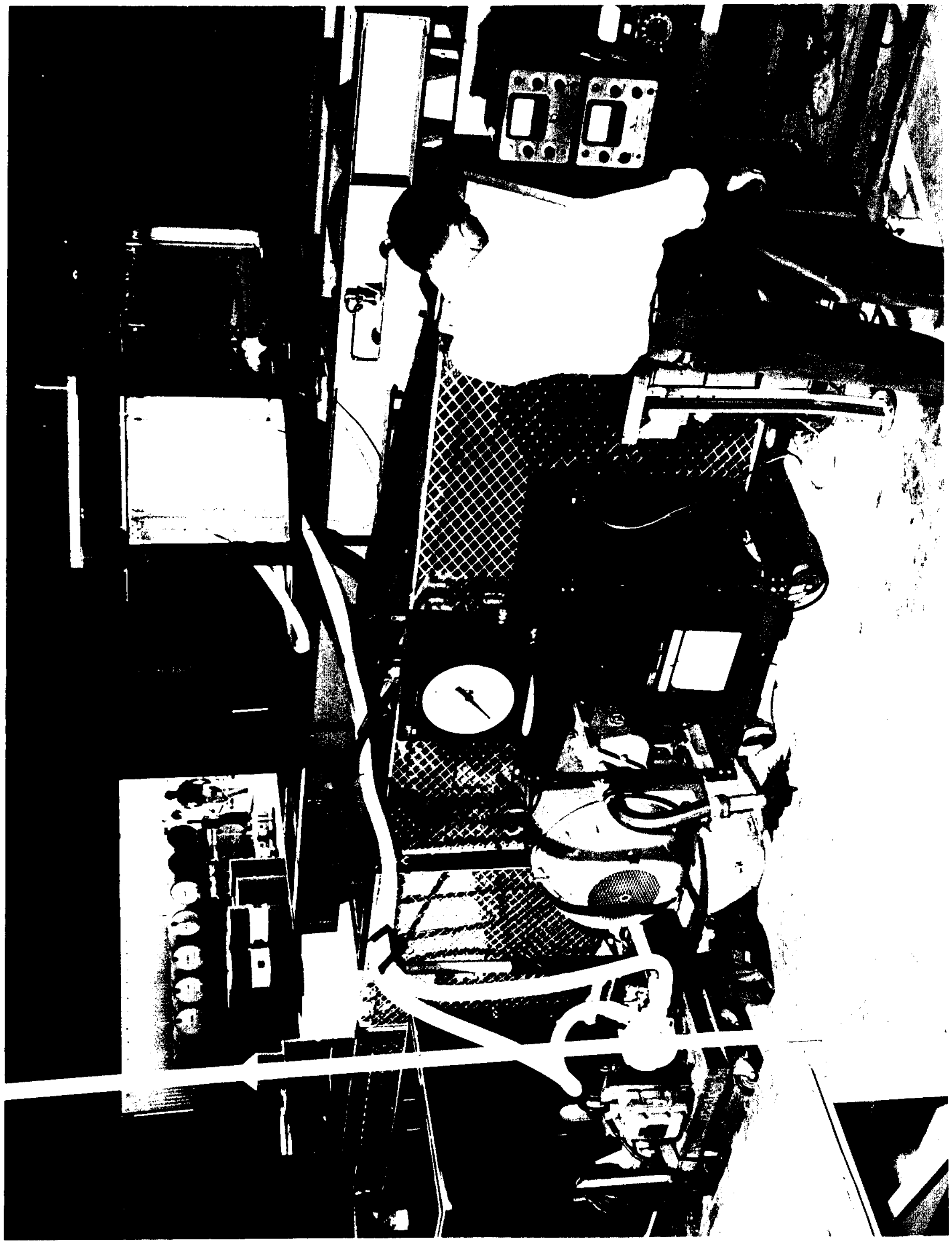


TEST CUBE NO. 2
LEFT AFT CORNER

BW-134353

BW-157738

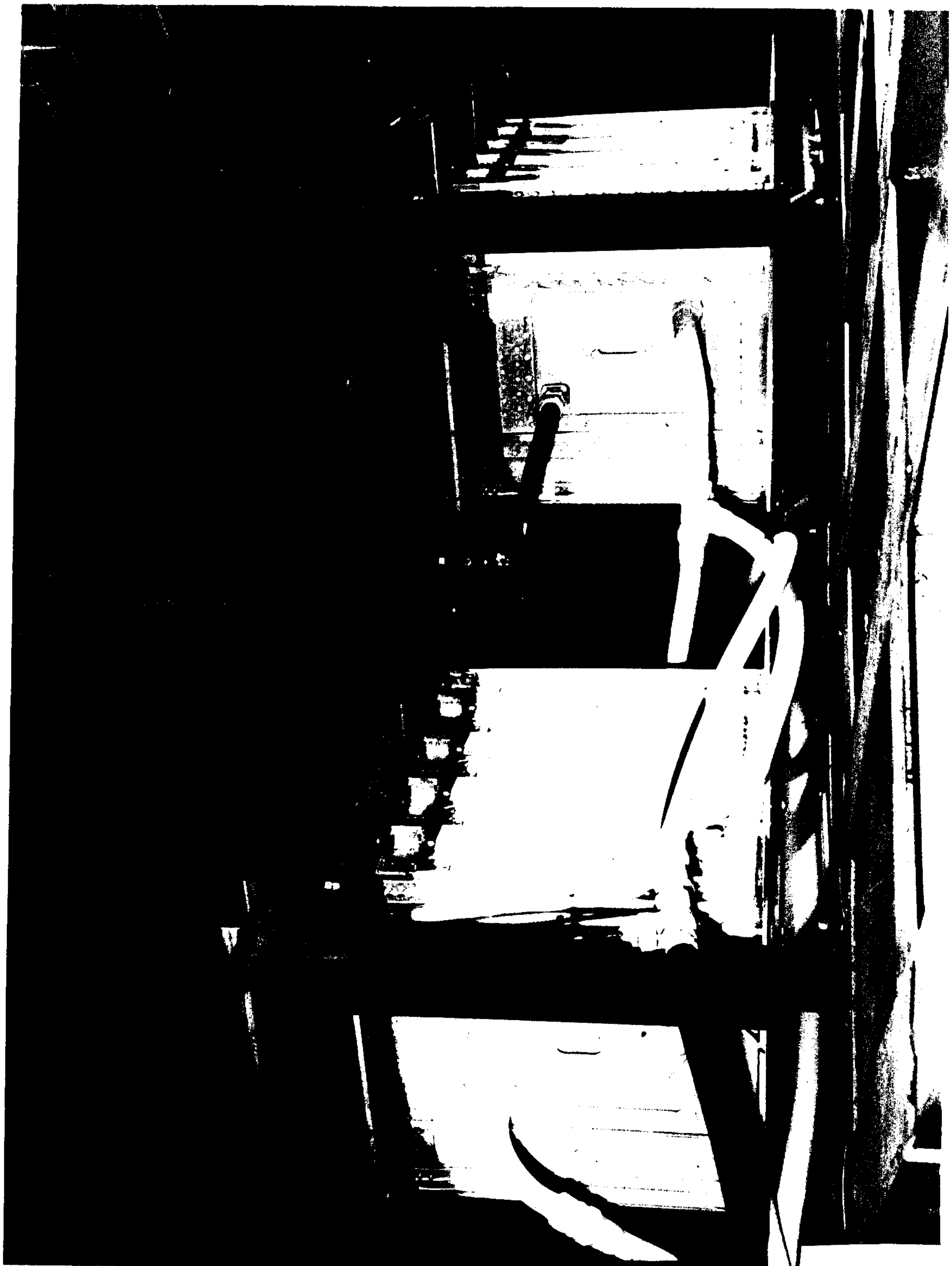
REVISED



BW-155843

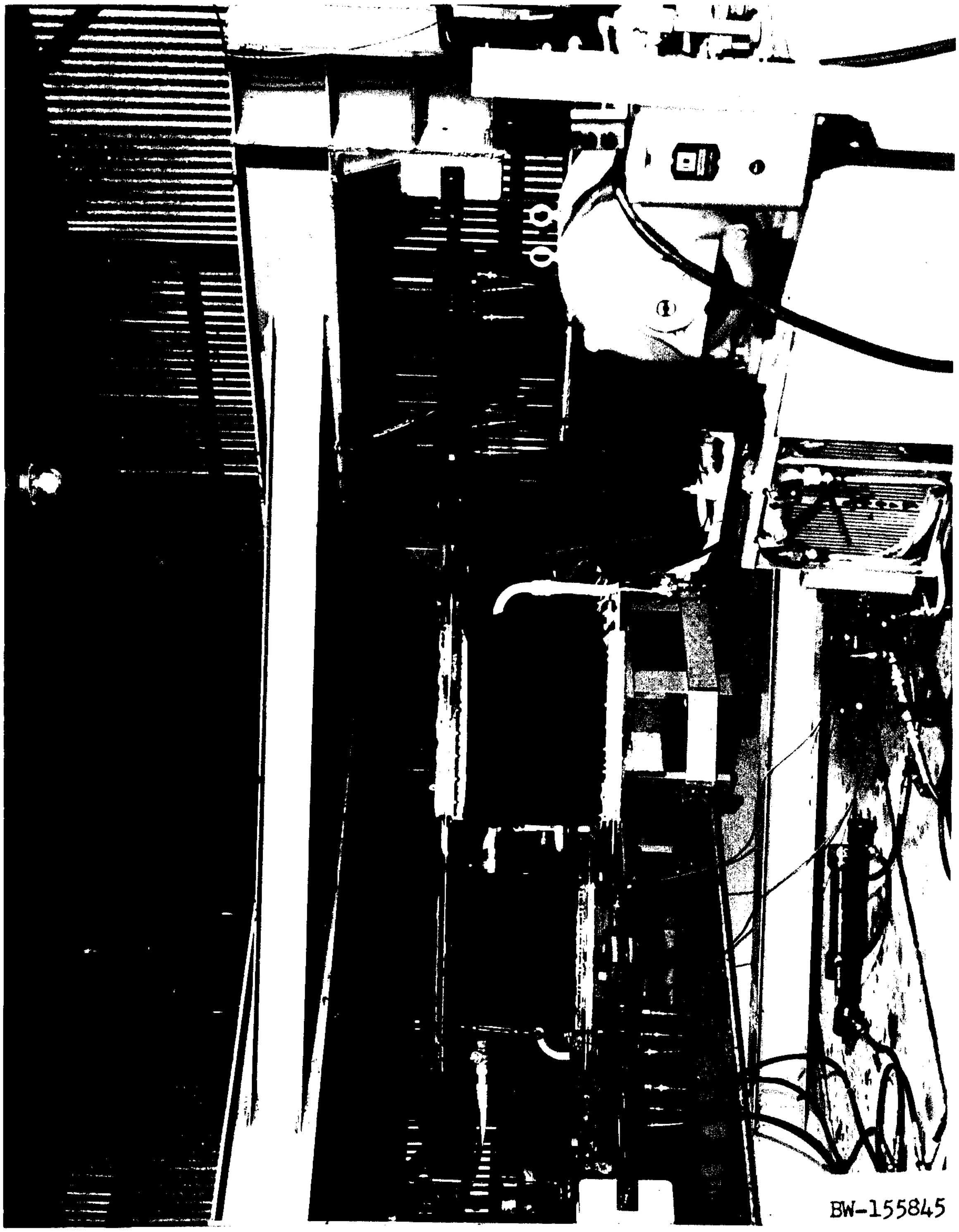
BW-157739

REVISED



BW-155844

BW-157740



RIGHT OBLIQUE VIEW OF TEST SET-UP

BW-155845

INBOARD END VIEW OF CUBE TO WHICH GAGES WERE APPLIED

REVISED

BW-157742

ADDENDA D

ENGINEERING DEVELOPMENT PROGRAM 829 FINISH SYSTEM, INTEGRAL FUEL TANK

I. To qualify a corrosive protective coating for application to integral fuel tanks and components. This is to be applied to detail parts, shall provide adequate corrosion protection and shall be compatible with sealant material.

B-52 ENGINEERING DEVELOPMENT PROGRAM - 829

II. STATEMENT OF WORK:

A. Background and Objectives

1. Basic Requirement for Application of MIL-S-4383 Topcoat Material to Interior of Integral Fuel Tanks.

The original requirement for topcoating of integral fuel tanks was for the protection of sealant material from the solvating action of the fuel. Fuel resistant sealants have now been developed which no longer require this protective topcoat. However, higher strength aluminum alloys are being used more and more extensively and such alloys are more susceptible to corrosion unless adequately protected. Since this topcoat material was fuel and moisture resistant it was natural that it should be used as a barrier material for corrosion protection of the metal structure.

2. Application and Service Experience.

On small tanks, protection of sealant by fill and drain or brush application of the topcoat material is readily accomplished. Service experience has shown, however, that for effective application the surfaces must be thoroughly clean, film thickness closely controlled and the applied film must be completely cured before being subjected to service. The MIL-S-4383 topcoat materials have relatively low adhesion and any change from optimum surface preparation or cure cycle adversely affects even this marginal adhesion.

On complex structures, such as integral wing tanks of large aircraft, such as B-52G, fill and drain coating application is all but impossible. Brush application can be accomplished in most instances; however, the quality of such application is questionable and the time element for application is staggering.

Paragraph deleted WR4

REVISED

B-52 ENGINEERING DEVELOPMENT PROGRAM 829

Page: 3
Date: 10-15-58
Rev.: 1-15-59WR4

II. STATEMENT OF WORK

3. Sealing State of the Art WR4

Use of a fuel resistant sealant which requires no topcoat has been adequate for sealant purposes. However, metal surfaces which have not been coated or sealed have shown evidence of insufficient corrosion protection. It is interesting to note here that panels prepared in the laboratory and those from the factory do not correlate as far as corrosion resistance is concerned. This has been shown, by laboratory tests, to be the result of shop "soil" and machining stress which has not been removed by normal metal cleaning procedures.

It has also become apparent that faying surfaces must be protected to eliminate the possibility of corrosion therein and to prevent abrasion of chemical conversion coating and corrosion of high strength alloys subjected to shop soils and corrosive atmosphere.

Observation of parts going through fabrication and assembly, point to a definite need for finish of detail parts as soon after fabrication as possible. This would minimize abrasion of chemical finish, allow optimum cleaning before application of finish and afford maximum corrosion protection to integral fuel tank parts. WR4

Since MIL-S-4383 material was designed as a sealant overcoating to protect tank sealants from the leaching effects of jet fuel and since sealant technology has advanced beyond the need for overcoating, corrosion protection should be afforded by a fuel resistant finish applied to detail parts. This would afford maximum protection provided the newer fuel resistant corrosion protective materials are entirely compatible adhesion-wise with sealant material. WR4

REVISED

D2-2100

B-52 ENGINEERING DEVELOPMENT PROGRAM 829

II. 3. Continued.

It is proposed herein that:

1. The newer fuel resistant, corrosion protective finishes be investigated for possible qualification as a finish for integral fuel tank detail parts.

2. Tests are to be conducted to determine optimum finish to sealant compatibility. This will establish not only fuel resistant, corrosion protective coating for the tank, but will also select a finish which is compatible with the sealant, i.e., a coating to which sealant will adhere equal to or better than to bare or conversion coated metal.

3. After the initial selections have been made, the more optimum systems (finish/sealant) shall be applied to a test tank. This test shall consist of heat-cold cycling, and fuel soak to provide final preproduction data.

B. Description of Work LT-829-1

1. New modified Epoxy and Polyurethane Coatings Shall be Tested as Follows: WR4

a. Metal Anchorage
b. Fluid Resistance
(1) Distilled water - 7 days.
(2) Jet reference fuel - 7 days.
(3) MIL-O-5606 fluid - 7 days.

REVISED

B-52 ENGINEERING DEVELOPMENT PROGRAM - 829

II. STATEMENT OF WORK:

1. New Epoxy and Polyurethane Coatings Shall be tested as Follows: (continued)

   c. Corrosion Resistance - 500 hrs.
   d. Cycling Humidity Resistance - 500 hrs.
   e. Low Temperature Flexibility.
   f. Fuel Contamination.

2. Those coatings which show superior qualities in the above testing shall be selected for LT-2 test procedure.

C. Description of Work LT-829-2

1. The Adhesion of Integral Fuel Tank Sealants to Finishes which show definite promise under LT-1 shall be tested as follows:

   a. Variation in sealant adhesion due to finish thickness.
   b. Variation in sealant adhesion due to finish cure time.
   c. Variation in sealant adhesion due to action of pre-sealant cleaner.
   d. Variation in sealant adhesion due to sealant cure.
   e. Variation in sealant adhesion under optimum conditions due to environmental exposure.
   f. Variation in sealant adhesion due to possible sealant/finish incompatability.

2. Adhesion testing shall be done as outlined under "Peel Test" per BMS 5-26.

D. Description of Work LT-829-3

Materials tested under LT-2 and which show acceptable Finish/Sealant compatibility shall be further tested as follows:

The material shall be applied to detail parts of fuel cell cubes. The cubes shall be assembled and sealant fillets applied.

These test cubes shall be filled with reference fuel* to 2/3 total capacity and plugged.

* MIL-F-5624C Grade JP-4

B-52 ENGINEERING DEVELOPMENT PROGRAM 829

II. STATEMENT OF WORK (Continued)

D. Description of Work LT-3.

The test cubes so filled shall be subjected to heat-cold cycling. Test cubes shall be opened at the end of 30 days and examined for evidence of corrosion and/or sealant finish breakdown. This test cycle shall be repeated on a 30 day basis until three months of cycling shall be completed.

E. Assignments.

1. LT 829-1. Materials and Process Unit Protective Finish Group

   a. Coordinate development of new finish material with leading paint manufacturers.

   b. Conduct screening tests of best submissions from paint vendors using BMS 10-15 Type I as control (SW E42GP13 + V66KP11 Converter) R

   c. Conduct final qualification tests on materials which pass screening tests.

   d. Submit coated panels of best finishes to Sealant Group for sealant adhesion studies.

   e. Assemble and coat test tanks as necessary to assist System-Materials Group in conducting static tank testing.

   f. Evaluate finishes at 30 day intervals during tank test program (LT 829-3).

   g. Write specification for integral tank coating material and release final report to include all phases of laboratory testing.

2. LT 829-2. Materials and Process Unit Sealant Group

   a. Conduct sealant adhesion tests on all paint finishes submitted by Protective Finish Group as a result of LT 829-1. Adhesion testing to be done as outlined under peel test per BMS 5-26.

B-52 ENGINEERING DEVELOPMENT PROGRAM - 829

Page: 7
Date: 10-15-53
11-24-53
Rev.: 12-3-53
12-15-53 WR_3

b. Apply sealant material to test tanks as necessary to assist Systems Materials Group in conducting static tank testing phase LT 829-3.

c. Evaluate sealant properties at 30 day intervals during tank test program LT 829-3.

d. Write summary report on sealant adhesion to finish materials and submit to Protective Finish Group.

3. LT 829-3-1 - Materials and Process Unit, System Materials Group WR_3

a. Fuel the test tanks and conduct hot and cold cycling tests at 30 day intervals. Slosh tanks, once daily, to wet all surfaces.

b. Open tanks every 30 days for finish and sealant inspection.

c. Sample fuel each 30 days and determine properties changes resulting from finish or sealant.

d. Submit summary report on tank testing to Protective Finishes Group at the end of 12 months.

4. LT 829-3-2 - Materials and Process Unit Protective Finishes Group, Sealants Group and Systems Materials Group WR_3

a. Disassemble old 4 ft. x 4 ft. x 4 ft. test tanks into detail components and remove old sealant and top coating (Sealants Group).

b. Apply Sherwin Williams E42GP13 primer to detail parts of test tanks after cleaning and Iridite 14 treatment. This material has been selected as a result of test in fuel call study and conclusion of 8 month exposure. (Protective Finish Group)

c. Re-assemble tank and seal with Coast Pro-Seal 890. Note: Repair leaks after sealing check for leakage.

d. Conduct Qualification Test Based on Requirements of D2-1057 "Pre-production Test IFT Model B-52G" (Power Plant Laboratory)

(1) Dyed JP-4 Leakage Test

REVISED

(a) Positive internal pressure of 11 psig. WR_3

(b) Hold pressure 24 hours

(c) Check for leakage

(d) Repair any sealant leaks (Process Sealants)

(2) Sealant Aging Test

(a) Fill tank 2/3 full of BMS 5-26 reference fluid and 1/3 full salt water (3%).

(b) Maintain filled tank at 140°F for seven days

(3) Cyclic Pressure Tests

(a) 1,000 pressure cycles while at condition in paragraph d. (2).

(b) Cycle to consist of 3 minutes duration from 6psig to -1.5psig.

(4) Drain tank, dry at 160 ±10°F for 72 hours, refill with JP-4.

(5) Slosh and vibration (Section V of D3-1136) except pressure test for 24 hours.

e. Slosh and vibration, hot and cold cycle, and sealant ageing tests per D2-1657 are to be performed on additional test finishes on small 12x12x6 inch tank (Systems Materials Group).

f. Submit report to Protective Finishes Group by 15 July 1959. WR_3

5. Systems Lab - H. Holmes

a. Dyed JP-4 Leakage Test.

b. Combination sealant ageing and cyclic pressure test.

c. Dry soak at 160°.

d. Slosh and vibration test

REVISED

B-52 ENGINEERING DEVELOPMENT PROGRAM 829

6. LT 829-3-3. Materials and Process Unit Protective Finishes Group, Sealants Group, Systems Materials Group, and Systems Laboratory

a. Strip and inhibit corrosion on old 4 ft.x4 ft.x 4 ft. test tank (Protective Finishes Group).

b. Replace abraded sealant fillets (Sealants Group).

c. Apply BMS 10-39 to interior of tank (Protective Finishes Group).

d. Cure finish for 72 hours.

NOTE: Repair leaks after sealing check for leakage.

e. Conduct qualification test bases on requirements of D2-1657 "Pre-production Test IFT Model B-52G (Systems Laboratory - H. Holmes).

(1) Dyed JP-4 Leakage Test

(a) Positive internal pressure of 11 psig.

(b) Hold pressure 24 hours.

(c) Check for leakage.

(d) Repair any sealant leaks (Process Sealants).

(2) Sealant Aging Test

(a) Fill tank 2/3 full of BMS 5-26 reference fluid and 1/3 full salt water (3%).

(b) Maintain filled tank at 140°F for seven days.

(3) Cyclic Pressure Tests

(a) 1000 pressure cycles while at condition in paragraph 6.e(2).

(b) Cycle to consist of three minutes duration from +6 psig to -1.5 psig.

(4) Drain tank, dry at 160°±10°F for 72 hours, refill with JP-4.

B-52 ENGINEERING DEVELOPMENT PROGRAM 829

(5) Slosh and vibration (Section V of D3-1136) except pressure test for 24 hours.

(6) Submit report to Protective Finishes Group by 1 December 1959.

ADDENDA E

WICHITA FLIGHT TEST 1070: FLIGHT TEST OF BMS 10-39 FUEL TANK COATING MATERIAL

B-52 FLIGHT TEST CHANGE MEMO

WFT 1070
MODEL B-52
DATE: 11-2-59R1

TITLE: FLIGHT TEST OF BMS 10-39 FUEL TANK COATING MATERIAL

AUTHORIZED BY: Contract AF33(600)-39114 CCN W-43 (ON-1223) R1

REFERENCES:

(a) Document D3-2247, "Development of a Fuel Tank Coating Conforming to BMS 10-39"

(b) Document D3-2398, "Laboratory Investigation of Corrosion Protection in B-52G Integral Fuel Tank"

(c) "Integral Fuel Tank Finish System", EDP 829

(d) Boeing Material Specification 10-39, "Fuel and Moisture Resistant Finish for Fuel Tanks"

BACKGROUND AND PURPOSE OF TEST

The original requirement for topcoating integral fuel tanks was for the purpose of protecting the sealant material from the solvent action of the fuel. Fuel resistant sealants have now been developed which no longer require this protective topcoat. However, high strength aluminum alloys are more susceptible to corrosion unless they are given adequate protection. Since MIL-S-4383 Buna Coating was the material used to overcoat sealant. it was natural that it should be chosen as a barrier material for corrosion protection of the metal structure. R1

Laboratory data, References (a) and (b), indicate that the present topcoat material, MIL-S-4383, is not entirely satisfactory as an integral fuel tank coating. This is due in part to a lack of corrosion inhibiting pigmentation within this material, and to the necessity for masking the material from the seal plane area. This masking is necessitated by lack of adhesion between the MIL-S-4383 coating and the sealant material.

These shortcomings of the MIL-S-4383 material have accentuated search for a better finish system for integral fuel tank areas. This search for a new material has been the main work accomplished by Reference (c) testing. The report of this work is contained in Reference (a) document. Reference (d) specification has been written to control procurement of material meeting the requirements set forth for an integral fuel tank coating.

REVISED

The study and testing, reported in Reference (a) document, show that under conditions of salt fog, condensing humidity, and fuel soak the new BMS 10-39 material, Reference (d), is superior in performance to the presently used MIL-S-4383 Buna topcoat. This superiority can be attributed to the very resistant resin of the BMS 10-39 material, and to the inclusion of corrosion inhibiting pigmentation. It is pointed out that sealant can be applied over the BMS 10-39 coating material without loss of sealant adhesion; however, BMS 10-39 should not be applied over sealant materials. Further testing is in progress which may eliminate need to mask sealant before application of coating.

The purpose of this test is to apply the MBS 10-39 material to the interior of a B-52G integral wing tank to further substantiate laboratory and simulated tank data as to the superiority of this coating system. The application of the BMS 10-39 material will not be required if previously used on this airplane to conduct WFT 1111. R1

GENERAL NATURE OF TEST

At least four bays of each main tank 1, 2, 3, and 4 of a B-52G aircraft will be stripped of the present Buna N Coating, and finished with an approved BMS 10-39 Coating. Cleaning, corrosion control, and finishing shall be under direct surveillance of the Protective Finishes Group. No accelerated or abnormal flight test is required. Monitoring and inspection of the interior of the finished tanks is desired on a convenient basis. It is anticipated that an examination approximately every 60 days will be sufficient. It is requested that this test be continued for a minimum of one year. Visual observation will be made by personnel from the Protective Finishes Group.

ENGINEERING GROUPS AFFECTED

Protective Finishes Group
Flight Test Section

COORDINATING RESPONSIBILITY:	Protective Finishes Group
ASSOCIATED CHANGES:	None
TEST AIRPLANE:	JB-52G AF57-6470
SUPPORT AIRCRAFT:	None

LIST OF GOVERNMENT PROPERTY: None

LIST OF CONTRACTOR FURNISHED EQUIPMENT

Normal spray equipment
BMS 10-39 coating

REVISED

WORK OUTLINE

I. Product Design Section

A. Protective Finished Group - R. A. Balbiers

1. Shall monitor stripping, cleaning, corrosion control and finishing of area.

2. Shall make visual observation on effectiveness of coating at intervals of approximately 60 days.

II. Flight Test Section

A. Flight Test Operations Unit - E. J. Sullivan

This unit shall be responsible for preparation of the test airplane to the desired configuration; planning, scheduling, conducting, obtaining and reducing the test data required by the Test Outline; and reporting the test progress and results to the Air Force as contractually required.

B. Flight Operations Unit - J. H. Goodell

This unit shall be responsible for over-all conductance of the flight test to satisfy the requirements of the Test Outline.

III. Test Outline

A. Airplane Configuration

1. A standard B-52G airplane in which the four bays of the main tanks 1, 2, 3 and 4 have been stripped of the Buna N coating and finished with an approved BMS 10-39 coating.

B. Test Procedure

1. Accomplish flight testing concurrent with other tests. No flights shall be conducted specifically for this test. Testing to continue for approximately one year, with inspections approximately every 60 days.

REVISED

C. Data Required

1. BMS 10-39 fuel tank coating material will be evaluated to determine:

   a. Corrosion protection qualities
   b. Film integrity
   c. Resistance to vibration
   d. Resistance to solvent action of fuel
   e. Repairability

D. Instrumentation

None

Approved by
Beverly W. Hodges - Manager - Product Design

Approved by R L McPherson
R. L. McPherson - Manager - Flight Test Section

Approved by
Richard W. Taylor - Engineering Manager - B-52 Weapon System

Original Release 8-31-59

R_1 Revision: 11-2-59 Added CCN authorization to page 1. Revised first paragraph under Background and Purpose of Test and the last paragraph in the same section.

ADDENDA F

WICHITA FLIGHT TEST 1111: PRELIMINARY EVALUATION

FLIGHT TESTS OF FUEL ANTI-ICING ADDITIVES

B-52 FLIGHT TEST CHANGE MEMO

WFT 1111
MODEL B-52
DATE: NOV 2 1959

TITLE: PRELIMINARY EVALUATION FLIGHT TESTS OF FUEL ANTI-ICING ADDITIVES

AUTHORIZED BY: Contract AF33(600)-39114 CCN W-44 (ON-1290)

REFERENCE:

(a) AMC TWX, IMSE-12-77-E to AFPR, BAC, dated 23 December 1958

(b) ECP 934, "Evaluation of Fuel Additives and Fuel Screen Coatings to Improve Low Temperature Operations"

(c) EDP 871, "Fuel Icing Investigation"

(d) Document D3-2135, "Fuel Icing Investigation"

(e) WADC Letter, WCLPPFF to Distribution, dated 2 July 1959, Subject: Anti-Icing Additives for Jet Fuel

(f) Boeing Document D3-2092-1, "Instrumentation Specification for Flight Testing JB-52G Airplane AF57-6470"

BACKGROUND AND PURPOSE OF TEST

Water in aircraft fuels, either dissolved or free water, is a problem item due to the potential of ice formation within the fuel system, Reference (a). Component malfunctions with resultant fuel starvation to the engines can be the direct result of this phenomena. Long flights at altitude with accompanying cold ambient temperatures result in reduced bulk fuel temperatures. The solubility of water in fuel is such that reduction of bulk fuel temperatures results in the formation of free water. This condition is more severe in integral tanks than bladder cells. Presently the fuel heaters are used to eliminate engine fuel system icing. An anti-icing fuel additive could be an alternate for engine fuel system icing and could provide additional protection to the airplane fuel system and provide better fuel tank sump drainage.

REVISED

To counteract this phenomena, ECP 934, Reference (b), and EDP 871, Reference (c) have been established to search for fuel anti-icing additives. Promising additives have resulted from these investigations, Reference (d), and should be further proven by flight tests to establish their effectiveness and system compatibility characteristics. If an effective anti-icing additive could be developed which is compatible with the aircraft fuel system, it is anticipated that it would be utilized by the next winter season by the Air Force, Reference (e).

GENERAL NATURE OF TEST

Four integral wing tanks of a B-52G aircraft will have three topcoatings, EC-1527, EC-776SR and BMS 10-39, in each tank. The application of the BMS 10-39 topcoating will not be required if previously applied to this airplane to conduct WFT 1070. Three anti-icing additives will be flight tested, one in each fuel tank, with one tank used as a control containing the same fuel as the fuel-additive tanks with the exception that no anti-icing additive will be present. From these flight tests, the most promising additive or additives, indicated by efficiency in preventing icing conditions and system compatibility characteristics, shall be further flight tested on a plane wide basis, including bladder type fuel tanks. The blending of the additive and fuel, fueling of the airplane and inspection of the sealant and topcoating will be under the direct surveillance of the Engineering Materials and Process Unit, System-Materials Group, supported by the Materials and Process Unit, Protective Finishes and Sealants Groups. It is anticipated that the sealant and topcoating will be inspected every ten calendar days. Inspection of the low pressure strainers will be required after each test flight. It is anticipated that approximately 20 flights consisting of 200 flight hours will be required to accomplish the test outline of this flight test change memo.

This flight test is an evaluation program for fuel anti-icing additives and not a qualification test.

ENGINEERING GROUPS AFFECTED:

System-Materials Group
Protective Finishes Group
Sealant Group
Flight Test Section
Systems Laboratories
Fuel Systems

REVISED

COORDINATING RESPONSIBILITY: Fuel Systems Group
ASSOCIATED CHANGES: None
TEST AIRPLANE: B-52G AF57-6470
SUPPORT AIRCRAFT KC-135

LIST OF GOVERNMENT PROPERTY:

Three (3) Fueling Trailers

LIST OF CONTRACTOR FURNISHED EQUIPMENT:

Analytical laboratory equipment necessary to analyze additive and water concentrations.

Pumps and plumbing required for blending of additive into the fuel, and saturating fuel with water

WORK OUTLINE

I. Product Design Group

A. System-Materials Group - C.R. Sponsler

1. Monitor the entire test program pertaining to Materials and Process

2. Sample and analyze blends of fuel and additive for additive and water content of the fuel at (1) blending trailers, (2) airplane tanks before flight, and (3) airplane tanks after flight.

3. Monitor the topcoating and sealing inspections conducted after every ten calendar days.

4. Responsible for inspection of bladder cells and other elastomeric materials in all fuel tanks in the airplane.

5. Write formal report on material compatability. Furnish to Fuel Systems Group for attachment to final report.

B. Finishes Group - R.A. Balbierz

1. Responsible for monitoring the application of topcoating material in each integral test fuel tank.

2. Responsible for inspection of the topcoating (1) before flight testing, and (2) after every 10 calendar days.

3. Job outline shall be submitted to the System-Materials Group for coordination prior to flight tests.

C. Sealant Group - C. E. Johnson

1. Responsible for inspection of sealant in the test tanks (1) before flight testing and (2) after every ten calendar days.

2. Job outline shall be submitted to the System-Materials Group for coordination prior to flight test.

D. System Laboratories Group - H. A. Holmes

1. Responsible for the blending of the fuel additives, saturation of the fuel with water and fueling of the airplane.

2. Coordination with System-Materials Group will be required for the sampling and analysis of samples and preparation of test fuels throughout the program.

E. Fuel Systems - R. L. Williams

1. Responsible for overall flight test coordination.

2. Responsible for flight mission requirements and instrumentation requirements.

3. Responsible for surveillance, evaluation and report of the fuel system performance other than Materials and Process responsibility.

4. Final report including fuel system performance.

REVISED

II. Flight Test Section

A. Flight Test Operations Unit - E. J. Sullivan

This unit shall be responsible for preparation of the test airplane to the desired configuration; planning, scheduling, conducting, obtaining and reducing the test data required by the Flight Test Outline; and reporting the test progress and results to the Air Force as contractually required.

B. Flight Test Instrumentation Unit - B. J. Bigley

This unit shall be responsible for the design, procurement, calibration, operation, and maintenance of all instrumentation installed to obtain the required data specified in the Flight Test Outline.

C. Flight Operations Unit - J. H. Goodell

This unit shall be responsible for over-all conductance of the flight test to satisfy the requirements of the Flight Test Outline.

III. Test Outline

A. Airplane Configuration

Standard B-52G configuration.

B. Test Procedure

1. Nos. 1, 2, 3, and 4 fuel tanks (Integral), shall be topcoated with EC-1527, EC-776SR and BMS 10-39 (in each tank).

2. Thermocouples shall be installed in Nos. 1 and 2 fuel tanks, each low pressure strainer fed by these tanks, and at the inlet of the Hamilton Standard Hydro-Mechanical fuel control unit. A record of the temperatures obtained shall be given to the System-Materials Group after each flight test. (Use the same thermocouple configuration as installed for WFT 1026 and 1028).

3. Install necessary instrumentation to determine the pressure differential across the low pressure strainer screens during flight testing. A record of the differential pressure shall be given the System-Materials Group after each flight test. (Use the same instrumentation for differential pressure as installed for WFT 1028).

4. Fuel heaters shall be removed from engines 2, 5, and 7 and replaced with tube installation per BAC drawing 35-7684.

C. Test Fuel Preparation

Three additives shall be blended with MIL-J-5624D, Grade JP-4, for flight testing. Blends will be prepared in fueling trailers, one trailer for each additive. The same trailer will be used for the same additive throughout the test program, to avoid contamination with other additives. The concentration of additives used in all phases of the flight test shall be the minimum effective concentration for water saturated fuel plus 2 cc. water per gallon of fuel.

Phase I of the test program will be conducted with fuel containing 100 ± 10 ppm water and minimum effective concentrations of additive for water saturated fuel plus 2 cc. water per gallon of fuel.

Phase II of the test program will be conducted with fuel containing 2 cc. of excess water per gallon of fuel. The fuel used for blending with additive for Phase II will contain 100 ± 10 ppm water. The excess water will be added during the fueling of the airplane. The additive concentration shall be the minimum concentration required for water saturated fuel plus 2 cc. water per gallon of fuel.

Phase III of the test program will be conducted using the most promising additive or additives from Phases I and II, previous laboratory tests, and JP-4 fuel containing 100 ± 10 ppm water. The test will be plane-wide, utilizing the body tanks (bladder type) as well as the integral tanks. Phase IV of the test program will be the same as Phase III, except 2 cc. of water per gallon of fuel will be used.

Phase V of the test program shall utilize a satisfactory additive, from the previous phases, in an integral tank and a bladder cell. The fuel shall be as received containing usage concentration of the additive. This will be a 60 day test to maintain sufficient lead time for any concurrent Air Force flight test program.

REVISED

In all phases of the flight test program, the control fuel tanks will contain the same conditioned JP-4 fuel as in the additive/fuel test tanks except no anti-icing additives will be present, in both integral and bladder control tanks.

The additives will be added to the fuel as follows:

1. Circulate the fuel in the trailer at 150 G.P.M.

2. Introduce the additive into the system, immediately adjacent to the suction side of the pump. The additive will be added continuously at a rate such that the required amount of additive is added as soon as the fuel has been circulated one complete cycle. Continue circulation until the fuel is required for fueling in the aircraft. Circulation should be for at least one hour, then an analysis made of additive concentration. Corrections, if any, should then be made. The System-Materials Group personnel shall be present during the blending operation.

3. Additive analysis of the fuel/additive blends and of the fuel shall be made after the additive is thoroughly mixed into the fuel (after one hour circulation) and prior to fueling of aircraft.

D. Flight Test Outline

Phase I

1. Topcoating and Sealant in Test Fuel tanks will be inspected prior to Flight Test Program. Pencil hardness and adhesion tests (tape) shall be conducted on each of the topcoatings. Hardness tests (Rex) shall be conducted upon the sealant. Visual inspection and whenever possible, hardness tests (Rex) will be conducted upon elastomeric materials in the integral tanks. This data shall be recorded and reported to the Materials and Process Unit, System-Materials Group.

REVISED

2. Additive/fuel blends, blended for Phase I, shall be pumped into the test fuel tanks, one additive/fuel blend in each tank. The control tank shall contain fuel, conditioned the same as the fuel/additive blends without additive. The control tank, No. 2 Main, shall be a control throughout the entire test program.

3. Samples for additive and water analysis will be taken after fueling of the airplane and after flight.

4. A complete record of temperatures at fuel strainers, fuel tanks and fuel control units, and differential pressure across the low pressure strainers will be kept during flight and the data submitted to the System-Materials Group at the end of each flight test.

5. The low pressure strainers will be checked for ice formation after each flight and photographs taken.

6. Topcoating, sealant, and elastomeric materials in the test fuel tanks will be inspected after the tanks have been exposed to fuel/additive for 10 calendar days. Pencil hardness and adhesion (tape) tests shall be conducted on the topcoat. Hardness tests (Rex) shall be conducted on the sealant and elastomers where possible. The data will be reported to the Materials and Process Unit, System-Materials Group. Inspection of the topcoating sealant and elastomers shall be made immediately on opening the fuel cells and again after 24 hours of drying. Cells can be sealed up again after checking topcoat and sealant with Engineering Inspection only. The time the fuel cells have been exposed to fuel additive shall be recorded with each inspection.

7. This phase shall consist of three flights and total time exposure of the fuel tanks to the fuel/additive for 10 calendar days. A flight time of approximately 10 hours each flight will be required, or sufficient time to reduce the bulk fuel and strainer temperature to known icing conditions. If known icing conditions cannot be reached, the fuel will have to be cooled below these conditions prior to fueling. This will be determined after the first flight test.

REVISED

8. Materials and Process Unit, System-Materials Group, Finishes Group, and Sealants Group shall be present during all inspections of the test fuel tanks and low pressure strainers, and shall be notified prior to opening of fuel tanks and the removing of the strut strainers.

9. The following fuel loading and usage sequence will be required for the flights in this phase:

Loading

Externals	Full	9,100.#
Outboard Wings	Full	14,924.#
Mains 1 and 4	Full	63,596.
Mains 2 and 3	32,000# ea.	64,000.
Center Wing	Full	21,015.
Forward Body	2,000#	2,000 (min.)
Mid Body	2,000#	2,000 (min.)
Aft Body	21,000#	21,000.
		197,635.#

NOTE: The first fuel loading of mains 1, 2, 3, and 4 after application of top-coating materials will be with 110°F fuel plus 2cc. excess water/gal. Additives as specified in paragraph III.C. for Phase I will be in the fuel for mains 1, 3, and 4. No additive in Main #2 fuel. The hot fuel may be loaded at any time prior to the first flight. Sump draining should be accomplished prior to flight.

Usage Sequence

1. Aft Body to 1 and 2)
   Main 2 to 3 and 4) - Take-off
   Main 3 to 5 and 6)
   Center Wing to 7 and 8)

2. Aft Body to 1, 2, 3, and 4) - Climb and use fuel until it
   Center Wing to 5, 6, 7, and 8) is depleted from these tanks

REVISED

3. Main 1 to 1 and 2
   Main 2 to 3 and 4
   Main 3 to 5 and 6
   Main 4 to 7 and 8

   After starting step 3 above, do not change sequence. Complete the flight with this setting and accomplish landing with a minimum of 4,000# in each main. Ed-ternal and outboard wing fuel will not be used during this phase of the flight test program.

Phase II

1. This phase of the flight test program shall be conducted the same as Phase I with the following exceptions:

   a. Fuel/additive blends shall be those blended for Phase II in Section C, Test Fuel Preparation.

   b. The control main fuel tank, tank No. 2, shall have fuel conditioned the same as the fuel/additive blends except no additive will be present. The fuel shall contain 100 ± 10 ppm water plus 2 cc of excess water/gallon of fuel.

   c. Two cc of excess water/gallon of fuel shall be added to all test tanks during fueling of the airplane.

   d. This phase shall consist of four flights and total time exposure of the fuel tanks to the fuel/additive for 10 calendar days. Three of these flights are to be 10 hours duration. The fourth flight is to be approximately 24 hours duration with in-flight refueling. Only the one additive which is to be recommended to the Air Force for their flight test will be used throughout the airplane. Fuel received during air refueling will also contain this additive but without excess water.

      NOTE: The first fuel loading of mains 1, 2, 3, and 4 at the beginning of phase II will be with 110° fuel plus 2 cc. of water/gal of fuel. Additives as specified in section C for Phase II will be in the fuel for mains 1, 3, and 4. No additive in main No. 2, the hot fuel may be loaded at any time prior to the first flight in Phase II after Phase I.

REVISED

e. The forward body tank (bladder) shall have a fuel/additive blend, selected from Phase I, added for test. The fuel shall contain 100 ± 10 ppm water plus 2 cc excess water/gallon of fuel. Hardness tests (Rex) shall be conducted on the forward body bladder cell prior to this phase and at each inspection period.

f. All groups shall submit a report to the System Materials Group to facilitate a possible recommendation to the Air Force by 1-1-60.

Phase III

1. This phase of flight test program will be plan-wide usage of an additive or additives determined from Phases I and II. The same tank used as a control tank in Phases I and II shall remain as a control tank. In addition a body tank (bladder) shall be used as a control tank through Phases III and IV. These control tanks shall contain the same conditioned fuel as the other tanks except no additive will be present.

   a. Topcoating, sealant, elastomers and bladder cells shall be inspected prior to this phase of the Flight Test program. Pencil Hardness and adhesion tests (tape) shall be conducted on each of the topcoatings. Hardness tests (Rex) shall be conducted upon the sealant. The elastomers and bladder cells shall have Hardness tests (Rex) conducted where possible, and visual inspection on remaining parts. This data shall be recorded and reported to the Materials and Process Unit, System-Materials Group.

   b. Fuel/additive blends shall be in all tanks, including body tanks (bladder type), except the control main tank, No. 2 main and the mid body tank (bladder type).

   c. The concentration of the additive in JP-4 fuel shall be the same as the concentration of the additive when used in Phases I and II.

d. All tanks shall contain the same conditioned JP-4 fuel and additive, containing 100 ± 10 ppm water. The control main fuel tank (integral) and control body tank (bladder) shall contain the same conditioned JP-4 fuel containing 100 ± 10 ppm water with no additive present.

e. The bladder cells shall be inspected after every 10 calendar days the cells have been exposed to fuel additive, by the Materials and Process Unit, System-Materials Group.

f. This phase shall consist of six flight tests and 20 calendar days of total exposure time of the cells to the fuel/additive. A flight time of approximately 10 hours each flight will be required or sufficient time to reduce the bulk fuel temperature to known icing conditions.

g. The remaining inspections and flight test conditions shall be the same as Phases I and II.

Phase IV

1. This phase of the flight test will be conducted the same as Phase III, using the same additive or additives as Phase III with the following exceptions:

   a. The additive concentration shall be the minimum effective concentration required for saturated fuel plus 2 cc excess water/gallon of fuel.

   b. 2 cc of excess water/gallon of fuel/additive blends shall be added to all tanks during fueling of the airplane.

   c. The control main fuel tank (integral) and the control body tank (bladder) shall contain the same conditioned JP-4 fuel with the 2 cc excess water/gallon of fuel, however, <u>no</u> additive will be present.

d. An inspection shall be made of the sealant, topcoating, and elastomeric materials after the last flight test. Information required is as specified in Phase III. 1. above.

e. All groups will submit a report to the Fuel Systems Group.

Phase V

1. This phase of the flight test shall utilize a satisfactory additive from Phases I, II, III, and IV, in an integral wing tank and the forward body tank. The fuel will be as received from the tank farm containing usage concentration of the additive.

2. Inspections shall be as in the previous phases and will be conducted every 10 calendar days.

3. This phase shall consist of flight tests for a 60 calendar day period to maintain sufficient lead time for any concurrent Air Force flight test program.

4. All groups shall submit a final report to the System Materials Group.

E. Data Required

1. Each engine fuel flow rate vs. time (all eight engines).

2. Each 200 mesh strainer fuel differential pressure vs. time (all eight engines) (use the same instrumentation for differential pressure as installed for WFT 1028).

3. Fuel temperature in Mains 1 and 2 (use the same thermocouple configuration as installed for WFT 1026).

4. Each fuel temperature at the 200 mesh strainer vs. time on engines 2, 4, 5, and 7 (use same thermocouple configuration for heater inlet and outlet temperatures as installed for WFT 1028).

REVISED

5. Fuel temperature at inlet of the Hamilton standard Hydro-Mechanical fuel control unit on engines 2 and 4. This temperature willbe taken downstream of engine driven pump (use same thermocouple configuration as installed for WFT 1026).

6. Each heater inlet and outlet fuel temperature vs. time on engines 1, 3, 6, and 8 (use same thermocouple configuration as installed for WFT 1028).

Approved by ______________________________
Beverly W. Hodges - Manager - Product Design

Approved by ______________________________
R. L. McPherson - Manager - Flight Test Section

Approved by ______________________________
Richard W. Taylor - Engineering Manager - B-52 Weapon System

REVISED

ADDENDA G

FLIGHT TEST EVALUATION OF INTEGRAL FUEL TANK COATINGS WFT 1070 AND WFT 1111

MATERIALS AND PROCESS UNIT JOB ASSIGNMENT SHEET

TITLE: Flight Test Evaluation of Integral Fuel Tank Coatings per WFT 1070 and WFT 1111

OBJECTIVE:

To determine the relative hardness (Pencil Hardness Test per MIL-C-27227), adhesion test (tape test per MIL-C-18273) and visual appearance of the integral fuel tank Coatings.

JUSTIFICATION:

This work is authorized by WFT 1070, Flight Test Evaluation of BMS10-39 Fuel Tank Coating Material, and WFT 1111, Preliminary Evaluation Flight Tests of Fuel Anti-Icing Additives.

CONCLUSIONS: Report No. 1 Observation 15 Day Exposure:

Mains No. 1 and No. 2. Very good some mild superficial corrosion see attached report.

Main No. 3. Slight softening of Buna Coating which recovers on drying. BMS10-39 coating very good. Some mild corrosion in some areas noted, see attached report

Main No. 4. Extreme softening of Buna Coating and rather heavy pigment floatation. Some recovery on drying. BMS10-39 coating in good condition. No corrosion detected. See attached report.

RECOMMENDATIONS: Continue Test as Outlined.

Start Date: 11-13-59	Charge No. 14-37106-56-1111	Job No. F2-198A
Sched. Comp. Date Phase I 12-2-59 over all 11-25-60	Contract No. AF 33(600)-39114	Eng. Hrs. (150)

Completion Date Phase I 12-5-59	CATEGORY (Research Only)	Engineer 12-5-59 J. Lockwood	Approval R. C. Ballard [illegible]

REVISED

FORM E-1656 R2

Tank Main Number	Material Designation	Pencil Hardness Bottom Init.	Bottom 2nd	Bottom 3rd	Side Init.	Side 2nd	Side 3rd	Top Init.	Top 2nd	Top 3rd	Tape Test Bottom	Tape Test Side	Tape Test Top	Visual Finish Evaluation
1	EC776SR	3B	3H		3B	3H		H	3H		*P	P	P	Very Good
	BMS10-39	H	H		H	H		H	H		P	P	P	Very Good
	EC1527	3B	HB		3B	H		HB	H		P	P	P	Very Good
2	EC776SR	3B	H		3B	2H		2H	2H		P	P	P	Very Good
	BMS10-39	H	2H		H	2H		H	2H		P	P	P	Very Good
	EC1527	B	F		B	H		H	H		P	P	P	Very Good
3	EC776SR	2H	2H		2H	2H		2H	2H		†P	P	P	Very Good - Bottom deposit
	BMS10-39	H	H		2H	H		2H	H		†P	P	P	Very Good. Bottom - deposit
	EC1527	H	B		H	2H		H	2H		†P	P	P	Very Good - Bottom Coated with deposit
4	EC776SR	<9B	5B		<9B	F		<9B	2H		†P	P	P	Slightly Blushed Some Pigment floatation
	BMS10-39	H	HB		F	H		F	H		†P	P	P	Very Good
	EC1527	<9B	<6B		<9B	B		<9B	F		†P	P	P	Pigmented Coating alligatored - Pigment floatation.

Date: 12-1-59
[signature]
observer
PHASE I
Report 1.

Report of any unusual conditions:

P denotes passed test

See attachment.

*slight pickup of overspray on tape
† Very difficult to obtain adequate adhesion of tape to coating.

CALC		REVISED	DATE
CHECK	[signature] 12-5-59		
APR			
APR	[signature]		
CONTRACT NO.			

Observations, Topcoat, WFT 1070 and 1111

F2-198A

BOEING AIRPLANE COMPANY
WICHITA, KANSAS

REVISED

FORM E-1686 R2

Coating Observation Summary - Report 1

Visual observations made on 1 and 2 December 1959 of finish within the No. 1, 2, 3 and 4 mains of Aircraft 57-6470 show that No. 1 and No. 2 mains are in very good condition and that the

BMS 10-39 coating in No. 3 and No. 4 mains is in very good condition.

No. 3 main, however, showed a slight softening of the Buna coating on the first observation when the tanks were opened. Upon drying the Buna coating had recovered.

No. 4 main showed the most change this was exhibited in the extreme softening of the film of the Buna coating and rather heavy pigment floatation and film "alligatoring". Some recovery of film strength is noted on drying.

All areas in mains passed the tape test after drying. Some slight overspray removal was noted in the EC776$R of Main No 1.

Corrosion Observations - Report 1

Main No 1

Bays 21 and 22 (EC776$R)

Mild corrosion has reoccurred on the upper skin in area that was not topcoated. Bay 21 has more corrosion than Bay 22. Corrosion is in initial stages. Corrosion is evidenced by appearance of black discoloration in bottom of "mill cutter marks" on machined surfaces.

Bays 23, 24, 25 and 26 are free of visibly detectable corrosion.

Main No. 2

Bay 5 and 6 (EC776$R)

Mild corrosion has reoccurred on the upper skin. This corrosion has started under the topcoating. The topcoating was intact in the area where corrosion was observed.

Bays 7, 8, 10 and 11 are free of visibly detectable corrosion.

Main No. 3

Bay 5 and 6 (EC776$R)

Corrosion has reoccurred on the upper skin. This corrosion has started under the topcoating. The topcoating was intact in the area where corrosion was observed.

Corrosion Observations (Continued)

Main No 3 (continued)

Bay 7 and 8 (BMS 10-39)

No corrosion present in these bays.

Bay 10 and 11 (EC 1527)

Corrosion has reoccurred on the upper skin and vent cover. This corrosion has started under the topcoating. The topcoating was intact in the area where corrosion was observed.

Main No 4.

Bay 21, 22, 23, 24, 25 and 26

No corrosion present in these bays.

Summary:

The mild corrosion present in Mains 1, 2 and 3 were determined to be comparable at the time of this inspection. Corrosion was judged to be superficial only.

BOEING AIRPLANE COMPANY
WICHITA DIVISION

D3-2780
Addenda G
Page 121A

TITLE: Flight Test Evaluation of Integral Fuel Tank Coatings Per WFT 1070 and WFT 1111

OBJECTIVE:

To determine the relative hardness (Pencil hardness Test per MIL-C27227), adhesion test (tape test per MIL-C-18273 dry) and visual appearance of the integral fuel tank coatings.

JUSTIFICATION:

This work is authorized by WFT 1070, Flight Test Evaluation of BMS 10-39 Fuel Tank Coating Material, and WFT 1111, Preliminary Evaluation Flight Tests of Fuel Anti-Icing Additives.

CONCLUSIONS: Report No 2 Observation 37 Day Exposure

Main No 1. Some softening on bottom of tanks greater than that on first inspection - All coatings intact. Small blisters throughout EC 1527 Coating. Superficial black corrosion has progressed slightly from that of Report No. 1 (See attached report)

Main No. 2. Coatings essentially unchanged from 1st inspection. Superficial black Corrosion has progressed very slightly from that of Report No. 1 (See attached report)

Main No. 3. No apparent degradation to any coatings. Superficial black corrosion appears to be same as at first periodic inspection. (See attached report)

Main No. 4. Severe degradation to EC776$R and EC1527. BMS 10-39 shows slight softening but no visible change. Superficial black Corrosion has initiated in areas

Start Date: 11-13-59	Charge No. 14-37106-56-1111	Job No. FE-198B
Sched. Comp. Date Phase II 12-28-59 over all 11-25-60	Contract No. AF 33(600)-39114	Eng. Hrs. 500
Completion Date Report 2 12-14-59	CATEGORY (Research Only)	Engineer 12-14-59 J. Lockwood / Approval 12/14/59 R.A. Bellberg

6-9 REVISED

bared by shrunken coating (EC776$R & EC1527). this corrosion was not detected at first periodic inspection (See attached report)

Tests be continued as scheduled, except that PFA 52MB be replaced by PFA55MB in Main No. 4

Coating Observation Summary - Report 2

Visual Observations 12 & 13 December 1959

Main 1. All three coatings show some softening on bottom panel of tank greater than that noted on first inspection. All coatings on top and sides of tank appear satisfactory with hardness same as that measured during initial inspection. EC 1527 coating has tiny blisters on all surfaces of tank. Blistering was reduced but not eliminated after 24 hours of drying

Main 2 The EC 776$R coating is essentially unchanged since first periodic inspection. The EC1527 coating softened to a slightly greater degree on the bottom of the tank but recovered to the original hardness after 24 hours drying. Top and sides coated with EC1527 were unchanged since first periodic inspection. BMS10-39 Showed no significant change since the first

periodic inspection, although this coating is showing slight hardening on top and sides of tank.

Main 3. No apparent degradation to any coating on top and sides as compared to No. 1 and No. 2 Mains. EC 776 SR and EC 1527 on bottom panels of No. 3 main were slightly harder than the same coatings in No. 1 and No. 2 Mains. BMS 10-39 was approximately same hardness as No. 1 and No. 2 Mains.

Main 4 The EC 1527 and EC 776 SR coatings show very bad degradation. BMS 10-39 coating shows slight softening but no change in visible appearance

Corrosion Observations Report 2.

Main 1. Superficial black corrosion noted in first inspection has progressed slightly. A new condition has appeared on all surfaces of the No 1 Main tank. A thin white deposit of sediment, different from white corrosion noted in other reports is generally deposited on all surfaces within this tank. Samples of this deposit have been collected for possible identifiation. The extent of this deposit on all surfaces makes inspection for corrosion quite difficult.

Main 2. Superficial black corrosion noted at the first inspection in No. 5 bay shows very slight progression. This corrosion is in the form of spots appearing under the 776 $R coating. Superficial corrosion was noted in No. 11 bay on plumbing fittings not noted in first periodic inspection.

Main 3. Superficial black corrosion on the upper wing surfaces appeared to be the same as at the first periodic inspection. It was not possible to

determine if any significant increase in corrosion had occurred. Bays No. 4 & No. 9 were comparable, visually, to bays No. 4 & No. 9 in the No. 2 Main tank. (Untopcoated bays).

Main 4. Superficial black corrosion on the untopcoated upper wing skin surfaces in bay No. 20 is same as that in bay No 20 of No. 1 Main. Bays No. 21, No. 22, No. 25 and No. 26 where the topcoat appears to have shrunken to expose bare surfaces, are beginning to show black superficial corrosion spots on upper surfaces. This corrosion was not detected at first periodic inspection.

6-9-61 REVISED

Date: 14 December 59
H.C. Humann - Stakood
observer

Report 2.

Tank Main Number	Material Designation	Pencil Hardness									Tape Test			Visual Finish Evaluation
		Bottom			Side			Top						
		Init.	2nd	3rd	Init.	2nd	3rd	Init.	2nd	3rd	Bottom	Side	Top	
1	EC776$R	3B/3H	6B	H	3B/3H	3H	2H	H/3H	3H	2H	Pass	Pass	Pass	Good condition except as noted *
	BMS10-39	H/H	3B	2H	H/H	H	2H	H/H	2H	2H	Pass	Pass	Pass	Good condition except as noted *
	EC1527	3B/HB	6B	HB	3B/H	4B	2H	HB/H	2H	2H	Pass	Pass	Pass	Small blisters throughout entire tank *
2	EC776$R	3B/H	4B	H	3B/2H	3H	2H	2H/2H	3H	2H	Pass	Pass	Pass	Good Condition
	BMS10-39	H/2H	3B	H	H/2H	2H	3H	H/2H	2H	3H	Pass	Pass	Pass	Good Condition ☆
	EC1527	B/F	6B	F	B/H	B	2H	H/H	2H	2H	Pass	Pass	Pass	Good Condition 6 small blisters around access
3	EC776$R	2H/2H	HB	B/2H	2H/2H	H	2H	2H/2H	H	3H	†Pass	Pass	Pass	Good Condition
	BMS10-39	H/H	HB	B/H	2H/H	2H	H	2H/H	H	H	†Pass	Pass	Pass	Good Condition
	EC1527	H/B	2B	B/HB	H/2H	2B	HB	H/2H	2B	HB	†Pass	Pass	Pass	Good Condition
4	EC776$R	<9B/5B	NR	6B	<9B/F	NR	HB	<9B/2H	NR	HB	†Pass	Pass	Pass	Very bad degradation
	BMS10-39	H/HB	3B	3B/F	F/H	B △	F	F/H	B	2H	†Pass	Pass	Pass	Good Condition
	EC1527	<9B/<6B	NR	6B/HB	<9B/B	NR	HB	<9B/F	NR	HB	†Pass	Pass	Pass	Very bad degradation

Init. Previous Report Wet/Dry

Report of any unusual conditions:

2nd This reading - wet

† very difficult to obtain adequate adhesion of tape to coating.

3rd This reading - dry

* white deposit throughout tank - Origin or Cause undetermined at this time.

NR Too soft - No Reading

☆ One spot 4 inches long on one lower stringer bare - appears to be due to inadequate cleaning.

△ one panel 6B

CALC		REVISED	DATE	Observations, Topcoat, WFT 1070 and 1111	F2-1988
CHECK	Stockwood 12-14-59				
APR					
APR	R.G. Bullinger 12/14/59			BOEING AIRPLANE COMPANY WICHITA, KANSAS	PAGE 6 OF 6

MATERIALS AND PROCESS UNIT JOB ASSIGNMENT SHEET

TITLE: Flight Test Evaluation of Integral Fuel Tank Coatings Per WFT 1070 and WFT 1111

OBJECTIVE:

To determine the relative hardness (Pencil hardness test per MIL-C-27227), adhesion test (Tape test per MIL-C-18293 dry and visual appearance of the integral fuel tank coatings

JUSTIFICATION:

WFT 1070 and WFT 1111

CONCLUSIONS: Report No 3 29 and 30 December 1959

Main 1, 2 & 4 Coatings show small increase in hardness in wet measurements. Recovery (Dry readings) remain about as before.

Main 3 Bottom - coatings show slight drop in wet reading - amounts to about 2 to 3 pencil hardness
Side - coating shows slight drop in wet reading
Top - No significant difference.
Recovery (Dry readings) remain about as before

Main 4 BMS 10-39 in Main 4 shows about 4 small hairline cracks along spar. Swelling and shrinking due to previous exposure to 52MB additive.

Recommendations: Tests be continued as set forth in report 2

Start Date: 11-13-59	Charge No. 14-37106-56-1111		Job No. F2-198C
Sched. Comp. Date Over All Phase II 12-28-59 11-25-60	Contract No. AF 33(600)-39114		Eng. Hrs. 500
Completion Date Report 3 12-30-59	CATEGORY (Research Only)	Engineer Stockwood	Approval R A Billing

6-61 REVISED

Corrosion Observations - Report #3

Main Tank #1. Superficial black corrosion noted in 1st and 2nd inspections has progressed slightly. Some of these corroded areas in Bays #21 & 22 have progressed to the extent that a light deposit of white corrosion products has appeared. Bay #20 in this tank and Bay #4 in #2 Main are equivalent (top coating on the bottom skin only in these Bays) and show a possible slight progression of corrosion since the last inspection.

Main Tank #2. Superficial black corrosion in Bay #5 has progressed slightly. Bay #6 was observed closely for first time since test started and has corrosion similar to that noted in Bay #5. One area in Bay #6 near the boost pump on the lower skin was not top coated and superficial black corrosion has started in this area. Bays #4, #9 and #12 (top coated on bottom skin only) show a slight increase in corrosion. Bays #9 and #12 in this tank show the least amount of corrosion of all the non-top coated Bays observed.

Main Tank #3. Superficial black corrosion shows a slight increase over the last inspection except in Bay #5. The rear spar in Bay #5 is approximately 5% covered with superficial black corrosion. Bays #4 and #9 (not top coated) are comparable to Bay #4 in #2 Main. Bay #12 shows slightly more corrosion than Bays #4 and #9 in this tank.

Main Tank #4 Superficial black corrosion has progressed slightly since the last inspection, except in Bay #21. The rear spar in Bay #21 is approximately 2% covered with superficial black corrosion and also some areas on the upper skin in this Bay. Bay #20 in this tank is comparable to Bay #12 in #3 Main.

CALC	E. Brown	12-30-59	REVISED	DATE	Observations, Corrosion WFT 1070 and WFT 1111	F2-198C
CHECK						
APR						
APR					BOEING AIRPLANE COMPANY WICHITA 1, KANSAS	PAGE 3
CONTRACT NO.						

Date: 30 Dec 1959

HCHumann & J Lockwood
observer

Report 3

Tank Main Number	Material Designation	Pencil Hardness									Tape Test			Visual Finish Evaluation
		Bottom			Side			Top						
		Init.	2nd	3rd	Init.	2nd	3rd	Init.	2nd	3rd	Bottom	Side	Top	
1	EC776$R	6B/H	2B	F	3H/2H	B	H	3H/2H	F	H	Pass	Pass	Pass	Good Condition
	BMS10-39	3B/2H	H	H	H/2H	H	H	2H/2H	H	H	Pass	Pass	Pass	Good Condition
	EC1527	6B/HB	2B	HB	4B/2H	HB	H	2H/2H	F	H	Pass	Pass	Pass	Blistering Not as great as previous report *
2	EC776$R	4B/H	B	HB	3H/2H	2H	H	3H/2H	2H	2H	Pass	Pass	Pass	Good Condition
	BMS10-39	3B/H	H	H	2H/3H	H	H	2H/3H	H	2H	Pass	Pass	Pass	Good Condition †
	EC1527	6B/F	B	H	B/2H	F	2H	2H/2H	F	2H	Pass	Pass	Pass	Good Condition
3	EC776$R	HB/B-2H	3B/3H	H/2H	H/2H	F/3H	2H	H/3H	3H	2H	Pass	Pass	Pass	Good Condition
	BMS10-39	HB/B-H	3B	H	2H/H	3B/H	H	H/H	H	H	Pass	Pass	Pass	Good Condition
	EC1527	2B/B-HB	3B	F	2B/HB	6B/B	F	2B/HB	B	F	Pass	Pass	Pass	Slight Progress in Aligatoring
4	EC776$R	NR/6B	6B	F	NR/HB	6B/H	H	NR/HB	H	H	Pass	Pass	Pass	Degradation shows No apparent progress
	BMS10-39	3B/3B-F	3B	B	B/F	F	B	B/2H	F	B	Pass	Pass	Pass	Some slight degradation apparent
	EC1527	NR/6B-HB	4B	2B	NR/HB	6B	B	NR/HB	B	B	Pass	Pass	Pass	Degradation Shows No apparent Progress

CODE

Init: Values wet/dry from last previous Report

2nd: This Observation wet reading

3rd: This Observation Dry reading

Report of any unusual conditions:

* Considerable area missed on back sides of stiffeners

† Spot 4-6 inches long on one lower stringer and Panel bare – appears to be due to inadequate cleaning

6-9-61 REVISED

CALC		REVISED	DATE	Observations, Topcoat, WFT 1070 and 1111	F2198C
CHECK	J Lockwood 12-30-59				
APR					
APR	RW Balberg 12-30-59			BOEING AIRPLANE COMPANY WICHITA, KANSAS	PAGE 4 OF 4

MATERIALS AND PROCESS UNIT JOB ASSIGNMENT SHEET

TITLE: Flight Test Evaluation of Integral Fuel Tank Coatings per WFT 1070 and WFT 1111

OBJECTIVE:
To determine the relative hardness (Pencil hardness test per MIL-C-27227), adhesion test (Tape test per MIL-C-18264 dry) and visual appearance of the integral fuel tank coatings.

JUSTIFICATION:

WFT 1070 and WFT 1111

CONCLUSIONS:

Top Coat Condition (Pencil Hardness)

No. 1 Main. All coatings gave hardness readings equivalent to readings made in initial dry state when tested on this wet test. Hardness of all coatings decreased slightly (1-2 pencil hardness values) after standing 24 hours. Ambient relative humidity during this 24 hour period was near 100% and coatings remained wet during the supposed dry out period.

No. 2 Main: Same as No. 1 Main. Some tiny blisters noted on BMS 10-39 coating in areas which had been abraided by previous pencil tests.

No. 3 Main: Initial wet readings were same as those taken at last inspection. After 24 hours slight softening occurred due to high humidity conditions.

Start Date: 11-14-59	Charge No. 14-37106-56-1111	Job No. F2-198 D
Sched. Comp. Date Phase III 1-30-60 over all 11-25-60	Contract No. AF 33 (600) - 39114	Eng. Hrs. 500
Completion Date Report 4 1-14-60	CATEGORY (Research Only)	Engineer E. Brown J Lockwood	Approval [illegible]

6-9-61 REVISED

FORM E-1686 R2

No. 4 Main: All coatings soft on initial wet reading. Slight increase in hardness after 24 hours drying. BMS 10-39 continuing to show deterioration as a result of exposure to PFA 52MB in phase I & II of Flight Test

Corrosion Observations

No. 1 Main: No change from inspection made on 12-30-59 except for normal progression of existing corrosion.

No. 2 Main: The upper skin in Bay #5 has an area (on stiffeners) that appears to have been reworked to remove corrosion products. Otherwise, the tank is relatively free of any corrosion.

No. 3 Main: Corrosion on the rear spar in Bay #5 has spread from 5% at the last inspection to 15% at this inspection. This corrosion is also intensifying in depth as noted by appearance of white corrosion products. Corrosion on the front spar in Bay #5 covers 3% of spar. Corrosion in Bay #5 has occured under EC776SR topcoating. The same condition exists in Bay #11 under EC 1527 topcoating (10% coverage on rear spar; first stages on front spar).

No. 4 Main: Superficial corrosion spreading under EC776SR topcoating in Bay #21 on the rear spar (10% coverage) and extensively on upper skin stiffeners along vertical web. No corrosion noted in other test Bays

6-9-61 REVISED

Date: 14 Jan 1960

J. Lockwood
observer

Report 4

Tank Main Number	Material Designation	Pencil Hardness Bottom Init.	Bottom 2nd	Bottom 3rd	Side Init.	Side 2nd	Side 3rd	Top Init.	Top 2nd	Top 3rd	Tape Test Bottom	Tape Test Side	Tape Test Top	Visual Finish Evaluation
1	EC776SR	2B/F	3H	2H	B/H	3H	2H	F/H	3H	2H	Pass	Pass	Pass	Good Condition
	BMS10-39	H/H	2H	H	H/H	2H	H	H/H	2H	2H	Pass	Pass	Pass	Good Condition
	EC1527	2B/HB	3H	H	HB/H	3H	2H	F/H	3H	2H	Pass	Pass	Pass	Blistering no greater than previous report
2	EC776SR	B/HB	F	HB	2H/H	2H	H	2H/2H	2H	2H	Pass	Pass	Pass	Good Condition
	BMS10-39	H/H	H	F	H/H	H	F	H/2H	H	H	Pass	Pass	Pass	Good Condition *
	EC1527	B/H	H	F	F/2H	H	F	F/2H	2H	2H	Pass	Pass	Pass	Good Condition
3	EC776SR	3B-3H/H-2H	H	H	F-3H/2H	H	4B/2H	3H/2H	H	2H	Pass	Pass	Pass	Good Condition
	BMS10-39	3B/H	HB	2B	3B-H/H	H	6B/HB	H/H	H	HB	Pass	Pass	Pass	Good Condition
	EC1527	3B/F	F	2B/HB	6B-B/F	5B/2B	6B/HB	B/F	F	HB	Pass	Pass	Pass	Good Condition
4	EC776SR	6B/F	5B	F	6B-H/H	5B	F	H/H	5B	F	Pass	Pass	Pass	No apparent Progress in degradation
	BMS10-39	3B/B	HB	HB	F/B	3B/H	B	F/B	H	F	Pass	Pass	Pass	3 Spots of Topcoat lifting
	EC1527	4B/2B	3B	HB	6B/B	3B	B	B/B	3B	HB	Pass	Pass	Pass	No apparent Progress in degradation

CODE

Init: Values - Last previous report wet/Dry

2nd: This report wet reading

3rd: This report Dry reading

Report of any unusual conditions:

* Slight Blistering at point of breakthrough on pencil test

Tanks were not dry at dry reading due to high ambient relative humidity.

CALC	J. Lockwood	1-14-60	REVISED	DATE
CHECK				
APR				
AFR	R. G. Bellamy	1-14-60		

Observations, Topcoat, WFT 1070 and 1111

F2-1972

BOEING AIRPLANE COMPANY
WICHITA, KANSAS

MATERIALS AND PROCESS UNIT JOB ASSIGNMENT SHEET

TITLE: Flight Test Evaluation of Integral Fuel Tank Coatings Per WFT 1070 and WFT 1111

OBJECTIVE:

To determine the relative hardness (Pencil hardness test per MIL-C-27227), adhesion test (Tape test per MIL-C-18264, dry) and visual appearance of the integral fuel tank coatings

JUSTIFICATION:

WFT 1070 and WFT 1111

CONCLUSIONS:

Main No. 1: No significant change was noted in either the wet or dry measurements of this main. No visual change in condition of finish.

Main No. 2: No significant change was noted in either the wet or dry measurements of this main No visual change in condition of finish

Main No. 3: Some slight softening of films in this Main in wet reading No loss of adhesion noted Dry readings virtually equivalent to those of Main 1. Visual appearance virtually same as previous report.

Main No. 4: Condition of this main not essentially different than that at previous report. Continued slight deterioration.

Start Date: 11-14-59	Charge No. 14-37106-56-1111		Job No. F2-198-E
Sched. Comp. Date 11-25-60	Contract No. AF 33(600)-39114		Eng. Hrs. 500
Completion Date 1-28-60 Report 5	CATEGORY (Research Only)	E. Brown Engineer J. Lockwood	Approval

FORM 6-9-61 REVISED

Observations - Corrosion on WFT 1070 and WFT 1111

Main No.1: The rear spar in Bay #21 has small superficial corrosion on approximately 30% of the area. Bays #25 and #26 have superficial corrosion in areas where the top coating has been removed. No corrosion was noted in Bays #23 and #24.

Main No.2: The lower spar chord in Bay #5 exhibits severe corrosion. The corrosion previously noted in Bays #5 and #6 do not appear to have increased. No corrosion noted in Bays #7, #8, #10 and #11.

Main No 3: The corrosion previously noted in Bays #5, #6, #10 and #11 doesnot appear to have increased since the last inspection. No corrosion noted in Bays #7 and #8. This tank was covered with yellow and white powdery deposits.

Main No.4: The corrosion previously noted in Bays #21, #22, #25 and #26 doesnot appear to have increased since the last inspection. No corrosion noted in Bays #23 and #24. This tank was covered with white powdery deposits

Date: 1-28-60

[signature] observer

Report 5

Tank Main Number	Material Designation	Pencil Hardness Bottom Prev	Bottom Pres Wet	Bottom Pres Dry	Side Prev	Side Pres. Wet	Side Pres Dry	Top Prev	Top Pres. Wet	Top Pres. Dry	Tape Test Bottom	Tape Test Side	Tape Test Top	Visual Finish Evaluation
1	EC776$R	3H/2H	2H	H	3H/2H	H	HB	3H/2H	2H	HB	Pass	Pass	Pass	No change from Report 4
	BMS10-39	2H/H	H	H	2H/H	F	H	2H/2H	H	H	Pass	Pass	Pass	
	EC1527	3H/H	H	H	3H/2H	H	HB	3H/2H	H	HB	Pass	Pass	Pass	
2	EC776$R	F/HB	F	H	2H/H	H	F	2H/2H	2H	2H	Pass	Pass	Pass	
	BMS10-39	H/F	F	H	H/F	H	H	H/H	H	H	Pass	Pass	Pass	
	EC1527	H/F	F	2H	H/F	F	2H	2H/2H	2H	2H	Pass	Pass	Pass	
3	EC776$R	H/H	6B	2H	H/HB/2H	6B	H	H/2H	HB	2H	Pass	Pass	Pass	
	BMS10-39	HB/2B	4B	H	H/6B/HB	2B	HB	H/HB	H	H	Pass	Pass	Pass	
	EC1527	F/2B/HB	6B	HB	5B/2B/HB	6B/2B	HB	F/HB	6B/2B	HB	Pass	Pass	Pass	
4	EC776$R	5B/F	6B	B	5B/F	6B	HB	5B/F	6B	HB	Pass	Pass	Pass	
	BMS10-39	HB/HB	H	F	3B/H/B	2B	F	H/F	2B	F	Pass	Pass	Pass	
	EC1527	3B/HB	3B	HB	3B/B	6B	HB	3B/HB	6B	HB	Pass	Pass	Pass	

CODE
1. Prev - Last previous Observation wet/Dry
2. Pres - This Observation
wet - as soon after opening the tanks as possible
Dry - After a minimum of 24 hours drying.

Report of any unusual conditions:

Condition of finish good except hardness readings somewhat low due to high relative humidity.

CALC	[signature] 1-28-60	REVISED	DATE
CHECK			
APR	R.A. Balbier 1-28-60		
APR			

Observations, Topcoat, WFT 1070 and 1111

F2-198E

BOEING AIRPLANE COMPANY
WICHITA, KANSAS

Date: 9 Feb 1960 [illegible]
[illegible] observer
Report 6

Tank Main Number	Material Designation	Pencil Hardness: Bottom Prev.	Bottom Pres. Wet	Bottom Pres. Dry	Side Prev.	Side Pres. Wet	Side Pres. Dry	Top Prev.	Top Pres. Wet	Top Pres. Dry	Tape Test: Bottom	Tape Test: Side	Tape Test: Top	Visual Finish Evaluation
1	EC776$R	2H/H	2H	F	H/HB	2H	H	2H/HB	2H	H	Pass	Pass	Pass	No Change in
	BMS10-39	H/H	H	H	F/H	F	F	H/H	F	H	Pass	Pass	Pass	finish from that
	EC1527	H/H	F	F	H/HB	2H	F	H/HB	2H	F	Pass	Pass	Pass	reported in report 5
2	EC776$R	F/H	2B	B	H/F	H	2H	2H/2H	H	2H	Pass	Pass	Pass	
	BMS10-39	F/H	2H	H	H/H	2H	2H	H/H	2H	2H	Pass	Pass	Pass	
	EC1527	F/2H	H	H	F/2H	H	H	2H/2H	H	H	Pass	Pass	Pass	
3	EC776$R	6B/2H	HB	HB	6B/H	F	HB	HB/2H	F	F	Pass	Pass	Pass	
	BMS10-39	HB/H	5B	B	2B/[illegible]	5B	B	H/H	5B	HB	Pass	Pass	Pass	
	EC1527	6B/HB	3B	3B	[illegible]/HB	2B	B	[illegible]/HB	2B	HB	Pass	Pass	Pass	
4	EC776$R	6B/B	2H	H	6B/HB	B	H	[illegible]/HB	2H	H	Pass	Pass	Pass	
	BMS10-39	H/F	2B	H	2B/F	2B	F	2B/F	H	H	Pass	Pass	Pass	
	EC1527	3B/HB	HB	HB	HB/HB	B	H	6B/HB	B	H	Pass	Pass	Pass	

CODE
1. Prev - Last previous Observation wet/Dry.
2. Pres - This Observation
Wet - as soon after opening the tanks as possible
Dry - After a minimum of 24 hours drying.

Report of any unusual conditions:

Drying time on Mains 1 & 2 materially less than that of Mains 3 & 4. This will account for slightly low readings in mains 1 & 2.

CALC	[signature] 2-10-60	REVISED	DATE
CHECK			
APR	R. A. Baltierra [illegible]		
APR			
CONTRACT No.			

Observations, Topcoat, WFT 1070 and 1111

BOEING AIRPLANE COMPANY
WICHITA, KANSAS

F2-198F
Report 6

Corrosion Observations

No. 1 Main: The corrosion previously noted in this tank does not appear to have increased since the last inspection

No. 2 Main: The corrosion previously noted in this tank does not appear to have increased since the last inspection.

No. 3 Main: The corrosion previously noted in this tank does not appear to have increased since the last inspection.

No. 4 Main: The corrosion previously noted in this tank does not appear to have increased since the last inspection. Superficial corrosion was present on the vent cover in Bay #24 where the top coating has been removed.

CALC	E. Brown	2-9-60	REVISED	DATE	Corrosion Observations, WFT 1070 And WFT 1111
CHECK					
APR					
APR	R.B. Bellinger	2/11/60			BOEING AIRPLANE COMPANY WICHITA 1, KANSAS
CONTRACT NO.					

F2-198F

Report 6

6-9-61 REVISED

FORM E-1686 R2

Date: 15 March 60

Hochwood
observer

Report 7

Tank Main Number	Material Designation	Pencil Hardness: Bottom, Prev	Bottom, Pres Wet	Bottom, Pres Dry	Side, Prev	Side, Pres Wet	Side, Pres Dry	Top, Prev	Top, Pres Wet	Top, Pres Dry	Tape Test: Bottom	Side	Top	Visual Finish Evaluation
1	EC776$R	2H/F	F	H	2H/H	HB	H	2H/H	F	2H	Pass	Pass	Pass	Coating almost colorless
	BMS10-39	H/H	F	F	F/F	B	HB	F/H	F	F	Pass	Pass	Pass	no significant change
	EC1527	F/F	HB	F	2H/F	F	HB	2H/F	H	F	Pass	Pass	Pass	no significant change
2	EC776$R	2B/B	HB	HB	H/2H	F	H	H/2H	H	2H	Pass	Pass	Pass	coating almost colorless
	BMS10-39	2H/H	HB	F	2H/2H	HB	F	2H/2H	F	2H	Pass	Pass	Pass	no significant change
	EC1527	H/H	HB	F	H/H	HB	F	H/H	F	H	Pass	Pass	Pass	no significant change
3	EC776$R	HB/HB	2B	F	F/HB	HB	F	F/F	HB	H	Pass	Pass	Pass	coating almost colorless
	BMS10-39	5B/B	HB	HB	5B/B	2B	HB	5B/HB	H	F	Pass	Pass	Pass	no significant change
	EC1527	3B/3B	5B	B	2B/B	B	2B	2B/HB	B	2B	Pass	Pass	Pass	no significant change
4	EC776$R	2H/H	5B	B	B/H	5B	B	2H/H	F	F	Pass	Pass	Pass	coating almost colorless
	BMS10-39	2B/H	5B	2B	2B/F	5B	2B	H/H	F	HB	Pass	Pass	Pass	no significant change
	EC1527	HB/HB	2B	2B	B/H	B	2B	B/H	HB	B	Pass	Pass	Pass	no significant change

CODE

1. Prev - Last previous Observation wet/dry
2. Pres - This observation
   Wet - as soon after opening the tanks as possible
   Dry - After a minimum of 24 hours drying.

Report of any unusual conditions:

Cold temperature and high humidity during this inspection have created somewhat lower readings in certain bays.

No Significant Change this Period

CALC	Hochwood 3-15-60	REVISED	DATE
CHECK			
APR	[illegible] 3/60		
APR			

Observations, Topcoat, WFT 1070 and 1111

BOEING AIRPLANE COMPANY
WICHITA, KANSAS

F2 198G

Report 7
PAGE

Corrosion Observations - Report #7

There was no apparent change in the extent or amount of corrosion present in any of the test tanks since the last inspection.

Date: 29 April 1962

J. Lockwood
observer

Report 8

Tank Main Number	Material Designation	Pencil Hardness									Tape Test			Visual Finish Evaluation
		Bottom			Side			Top			Bottom	Side	Top	
		Prev	Pres. Wet	Pres. Dry	Prev	Pres. Wet	Pres. Dry	Prev	Pres. Wet	Pres. Dry				
1	EC776$R	F/H	H	F	HB/H	H	F	F/2H	H	F	Pass	Pass	Pass	No significant change
	BMS10-39	F/F	H	HB	B/HB	H	HB	F/F	H	HB				
	EC1527	HB/F	HB	F	F/HB	F	F	H/F	F	F				
2	EC776$R	HB/HB	B	HB	F/H	F	H	H/2H	F	H				
	BMS10-39	HB/F	H	HB	HB/F	H	F	F/2H	H	F				
	EC1527	HB/F	F	F	HB/F	F	F	F/H	H	F				
3	EC776$R	2B/F	2B	H	HB/F	HB	H	HB/H	HB	H				
	BMS10-39	HB/HB	2B	F	2B/HB	B	F	B/F	B	F				
	EC1527	5B/B	3B	HB	B/[illegible]	3B	HB	B/2B	3B	HB				
4	EC776$R	5B/B	2B	F	5B/B	F	F	F/F	F	F				
	BMS10-39	5B/2B	F	HB	5B/2B	F	HB	F/HB	F	HB				
	EC1527	2B/2B	3B	B	B/2B	2B	B	HB/B	B	B				

CODE
1. Prev - Last previous Observation w/Dry.
2. Pres - This observation
wet - as soon after opening the tanks as possible
Dry - After a minimum of 24 hours drying.

Report of any unusual conditions:

No significant change noted in the Topcoat during this period.

CALC.	[signature]	4-29-62	REVISED
CHECK			DATE
APR	[signature]		
APR			

Observations, Topcoat, WFT 1070 and 1111

BOEING AIRPLANE COMPANY
WICHITA, KANSAS

F2-1024

PAGE

6-9-61 REVISED

Corrosion Observations - Report #8

There was no apparent change in the extent or amount of corrosion present in any of the test tanks since the last inspection

CALC	[signature]	5-3-60	REVISED	DATE	Observations, Corrosion	F2-190H
CHECK					WFT 1070 and 1111	
APR						Report 8
APR	[signature]				BOEING AIRPLANE COMPANY WICHITA, KANSAS	PAGE
						2
CONTRACT NO.						

Date: 20 Sept 1960

[illegible]
observer

Report #9

Tank Main Number	Material Designation	Pencil Hardness Bottom Prev.	Bottom Pres. Wet	Bottom Pres. Dry	Side Prev.	Side Pres. Wet	Side Pres. Dry	Top Prev.	Top Pres. Wet	Top Pres. Dry	Tape Test Bottom	Tape Test Side	Tape Test Top	Visual Finish Evaluation
1	EC776SR	H/F	2H	HB	H/F	H	H	H/F	H	H	Pass	Pass	Pass	No Significant Change
	BMS10-39	H/HB	B	B	H/HB	B	F	H/HB	H	F				
	EC1527	HB/F	HB	B	F/F	F	F	F/F	F	F				
2	EC776SR	B/HB	B	HB	F/H	H	H	F/H	H	H				
	BMS10-39	H/HB	HB	F	H/F	H	H	H/F	H	H				
	EC1527	F/F	HB	F	F/F	F	F	H/F	F	F				
3	EC776SR	2B/H	B	F	HB/H	H	H	HB/H	H	H				
	BMS10-39	[illegible]/F	B	HB	B/F	H	F	B/F	H	F				
	EC1527	2B/HB	2B	HB	[illegible]	F	F	2B/HB	F	F				
4	EC776SR	[illegible]/F	HB	HB	F/F	H	F	F/F	H	F				
	BMS10-39	F/HB	HB	2B	F/HB	H	B	F/HB	H	B				
	EC1527	2B/B	HB	HB	2B/B	H	F	B/B	H	F				

CODE
1 Prev - Last previous Observation Dry
2 Pres - This observation
Wet - as soon after opening the tanks as possible
Dry - After a minimum of 24 hours drying.

Report of any unusual conditions:

No Significant Change noted during this exposure period
— 30 [illegible] day exposure from Report 8 —

CALC	[illegible]	REVISED	DATE	Observations, Topcoat WFT 1070 and [illegible]	F2-103
CHECK					
APR	[illegible]				
APR				BOEING AIRPLANE COMPANY WICHITA, KANSAS	PAGE

Date: 16 & 17 March 1961

J Lockwood
observer

Report #10

Tank Main Number	Material Designation	Pencil Hardness: Bottom — Prev	Bottom — Pres Wet	Bottom — Pres Dry	Side — Prev	Side — Pres Wet	Side — Pres Dry	Top — Prev	Top — Pres Wet	Top — Pres Dry	Tape Test: Bottom	Tape Test: Side	Tape Test: Top	Visual Finish Evaluation
1	EC776$R	2B/HB	2H	2H	H/H	3H	2H	H/H	3H	2H	Pass	Pass	Pass	
	BMS10-39	B/B	F	H	B/F	H	H	H/F	H	H				
	EC1527	HB/B	HB	F	F/F	H	H	F/F	H	H				
2	EC776$R	B/HB	F	H	H/H	2H	2H	H/H	2H	2H				
	BMS10-39	HB/F	F	H	H/H	H	2H	H/H	H	2H				
	EC1527	HB/F	F	F	F/F	H	F	F/F	H	F				
3	EC776$R	B/F	HB	F	H/H	H	F	H/H	H	F				
	BMS10-39	B/HB	HB	H	H/F	2H	H	[illegible]	F	H				
	EC1527	2B/HB	2B	F	F/F	2B	H	F/F	2B	H				
4	EC776$R	HB/HB	F	F	H/F	H	H	H/F	H	H				1
	BMS10-39	HB/2B	HB	F	H/B	HB	2H	H/B	HB	2H				1
	EC1527	HB/HB	4B	2B	H/F	4B	4B	H/F	4B	4B				1

Report of any unusual conditions:

No significant change noted during this exposure period

1 Continued degradation since original exposure to PFA 52MB.

CODE

1. Prev - Last previous Observation wet/Dry
2. Pres - This observation
   wet - as soon after opening the tanks as possible
   Dry - After a minimum of 24 hours drying.

CALC	J Lockwood 3-17-61	REVISED	DATE
CHECK			
APR			
APR	[illegible] 3/20/61		

Observations, Topcoat, WFT 1070 and 1111

F-2

Corrosion Observations - Report #10

There was no apparent change in the extent or amount of corrosion present in any of the test tanks since the last inspection.

CALC	C Brown	3-17-61	REVISED	DATE	Observations, Corrosion
CHECK					WFT 1070 and 1111
APR	For RAB by GLE 3-17-61				BOEING AIRPLANE COMPANY WICHITA 1, KANSAS
APR					
CONTRACT NO.					

F2-198J
Report 10
PAGE 2

REVISED 6-9-61

FORM E-1686 R2

ADDENDA H

MATERIALS AND PROCESS UNIT JOB S-2-425

INTEGRAL WING TEST CUBE EVALUATION OF SEALANT-FINISH SYSTEM

REVISED

B-52G INTEGRAL WING TEST CUBE EVALUATION OF SEALANT, FINISH SYSTEM

'cc: 7100 - C. B. Barlow - II
2-5543 - M. Kushner - Seattle (28-81)
4-7012 - W. L. Slosson - Seattle (29-11)
6-7773 - F. N. Markey - Renton (74-83)

OBJECTIVE:

To coordinate the assembly of the Wing Station 492 test cubes, application of finishes and sealants, testing of the completed cubes, and to perform the evaluation of sealant test results.

SCOPE:

Two cubes were tested. The first was completely disassembled and stripped of primer and sealant, primed with BMS 10-11, reassembled with BMS 5-44 faying surface seals and sealed with BMS 5-44 fillet seals.

The second was not disassembled but was stripped, primed with BMS 10-39 primer and sealed with BMS 5-44 fillets. Some areas were coated with BMS 10-39 primer over the fillets.

JUSTIFICATION:

Pilot scale evaluation of Finish-Sealant Systems may reveal problem areas not observable on a laboratory scale and at a cost much less than that of full scale operational tests.

CONCLUSIONS:

1. The first cube using the BMS 10-11 primer and BMS 5-44 faying surface and fillet seals satisfactorily passed the testing program of Reference 2 and 4.

2. The second Wing Station 492 Test Cube Test using BMS 10-39 finish and BMS 5-44 fillet seals with some areas topcoated with BMS 10-39 finish satisfactorily passed a similar testing program (See Reference 5) and demonstrated that BMS 10-39 finish was compatible with BMS 5-44 sealant whether applied first as a primer or applied over the sealant as a topcoat.

RECOMMENDATIONS:

1. It is recommended that the sealant finish system of BMS 5-44 sealant with BMS 10-39 finish be considered as compatible and that BMS 10-39 be considered as suitable for applications either over or under the cured BMS 5-44 sealant.

REFERENCES:

1. EDP 829, Finish System, Integral Fuel Tank.

2. System Laboratories Unit, Power Plant Test Section, Test Report 330-2, Finish System, Integral Fuel Tank.

3. Materials and Process Unit Report S-2-404, Pro-Seal 890 and EC 1675 - BMS 10-11 Type I, Primer Compatibility.

4. System Laboratories Unit, Power Plant Test Section, Test Report 330-3 Finish System, Integral Fuel Tank - Extended Soak.

5. System Laboratories Unit, Power Plant Test Section, Test Report 330-6 Finish System, Integral Fuel Tank.

6. EEO EDP 829-001, Wing Station 492 Test Cube.

7. D3-2434, B-52G Integral Wing Test Cube Evaluation.

MATERIALS AND EQUIPMENT:

1. BMS 5-44, Integral Fuel Tank Sealant B-52G.

2. Sealing application tools, gun, cartridges, nozzles, fairing tools, etc.

3. Leak Detection equipment, Bubble Solution, Phenolthalein Indicator, etc.

4. Jet Reference Fluid per BMS 5-44 (or per BMS 5-26C).

5. Aqueous Salt Solution (3 wt.% NaCl).

6. Two Wing Station 492 Test Cubes available from previous testing (See Reference 7).

PROCEDURE:

1. The first test was begun by completely dismantling the test cube (See Reference 6) stripping the old sealant, priming the individual parts with BMS 10-11, reassembling with BMS 5-44 faying surface seals throughout, and sealing the test cube with BMS 5-44. The cube was then leak tested with air and soap solution and the leaks repaired. The cube was then tested per Reference 2 which included a 11 psig soak at room temperature for 24 hours using MIL-J-5624D, Grade JP-4 (dyed red). This was followed by a sealant aging and cycling test using 79 gallons of Jet Reference Fluid per BMS 5-44 (or BMS 5-26C) and 39 gallons of a 3% solution of salt water at 140°F. for 72 hours which included 1000 cycles of + 6 psig and -1.5 psig pressure. This was followed by a hot air dry at 160°F. for 77 hours. A Slosh and Vibration test followed which included 79 gallons of MIL-H-3136 Type I test fluid sloshed at 14 CPM thru an angle of 30° at a temperature of -65°F. while

being vibrated at 1960 CPM with an amplitude of 0.032" for a period of 24 hours. This test was followed by a repeat of the 11 psig soak with JP-4 at room temperature. Results of this test were satisfactory and the test was extended with an ambient temperature soak in Jet Reference Fluid per BMS 5-44 for a period of three months with monthly sealant inspection (See Reference 4). The sealant was satisfactory and testing was terminated on 8 June 1959.

2. The second cube was desealed without disassembling and primed with BMS 10-39 finish. The cube was then sealed with BMS 5-44, Type B-2, sealant and cured at room temperature. Some areas were spray coated over the sealant fillets with BMS 10-39 finish. Testing similar to the first cube was accomplished per Reference 7.

 NOTE: Subsequent investigation disclosed that the first test was conducted using Cube No. 2 of Reference 7 and the second test was conducted using Cube No. 1 of Reference 7.

RESULTS:

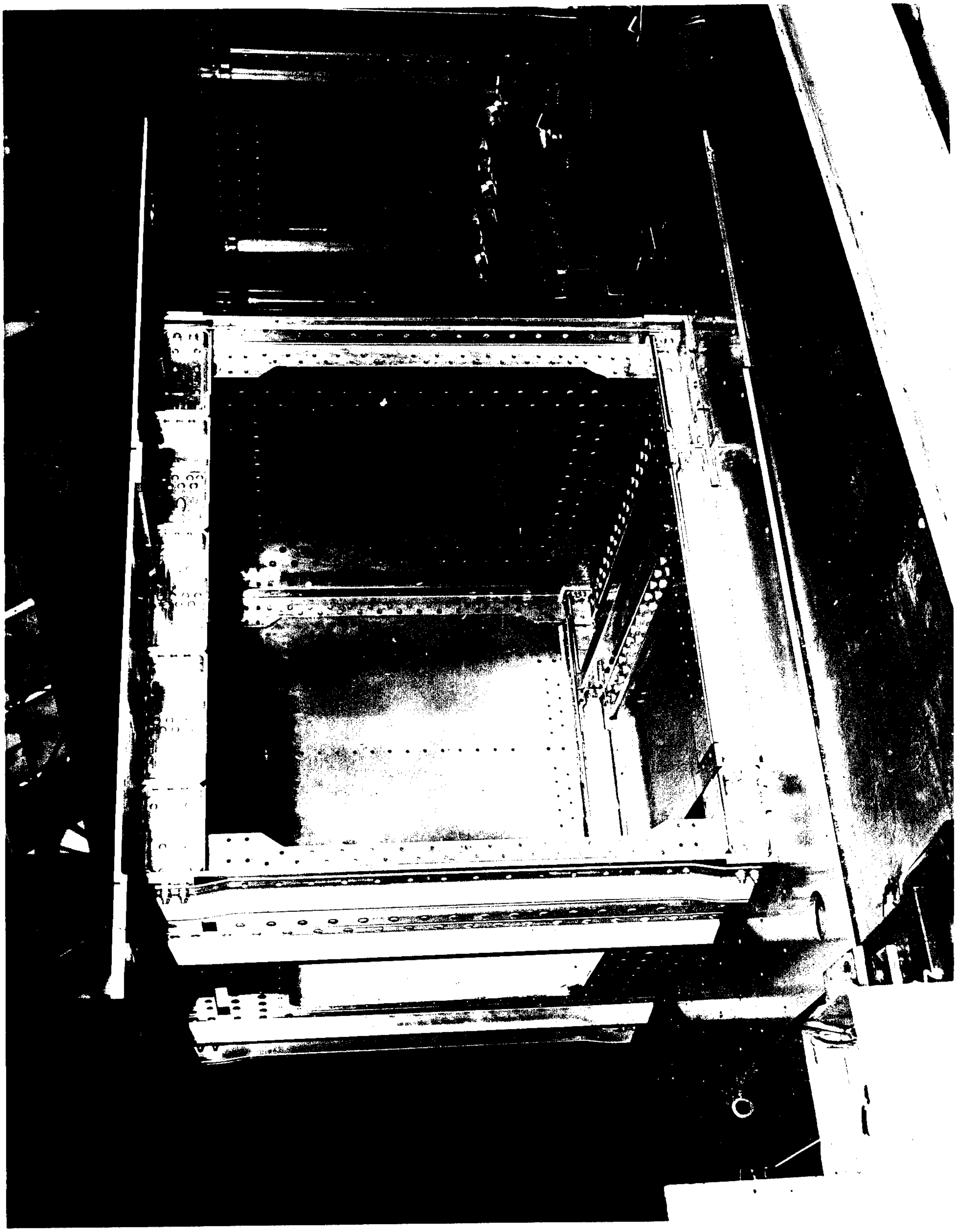
1. Results of testing on the first cube disclosed that BMS 10-11, Type I, primer is compatible with BMS 5-44 sealant but subsequent investigations (See Reference 3) revealed that incompatibility could occur with some batches of the primer.

2. Results of testing on the second cube indicate that the BMS 10-39 - BMS 5-44 system is compatible whether the BMS 10-39 is applied prior to sealing or as a topcoat (as a result of primer repairs). Subsequent and current laboratory testing of this system indicate that no difficulties will be experienced with this system.

3. As a further measure of the sealant quality each fillet was manually removed with no trace of adhesion failure being observed.

4. The one seep leak detected during the last pressure check was caused by an air bubble located in the sealant over the butt end of a self sealing rivet and adjacent to a fillet along a fuel dam. The leak path was traced and was reparable but could not be attributed to a failure of the system.

5. BWA-14924 is an illustration of one of the test cubes during the original fabrication (See Reference 7) and is attached to illustrate the nature of the test cubes.



BW-157743

ADDENDA I

SYSTEMS LABORATORY REPORT 330-6: FINISH SYSTEM, INTEGRAL FUEL TANK

REVISED

WD
Copies: 7100 - C. Johnson - I (2)
2-7750 - D. J. Downey - 04-34

SYSTEMS LABORATORIES UNIT
POWER PLANT TEST SECTION
TEST REPORT

Title of Test: Finish System, Integral Fuel Tank

Purpose of Test: To qualify a corrosion protective coating for application to integral fuel tanks and components.

References:
(a) EDP No. 829 (LT 829-3-3)
(b) Systems Laboratories Report No. 330-5, dated 28 August 1959.
(c) Photograph BWA-13374, page 20
BWA-13804, page 21

Remarks:

I. The Finish System Cube was tested per Reference (b).

II. The following tests were performed on the finish system test cube in the indicated sequence, however, the sealant inspections throughout these tests were performed by Process Unit personnel.

A. Leakage Test (Data, pages 4 through 6)

1. The test cube was filled with dyed JP-4 and a pressure of 11 psig was applied. Leakage appeared immediately at the lower wing stiffeners. Process personnel inspected the leakage and repaired the sealant. Three additional leakage areas were detected and repaired on successive pressure checks.

2. An internal pressure of 11 psig was applied to the cube for a 24 hour period.

3. As the slight leakage of fuel which occurred during test was not in test area, the test cube satisfactorily completed the leakage test

B. Aging and Cycling Test (Data, page 7 through page 10)

1. The test cube was filled with approximately 80 gallons of BMS 526 reference fluid and approximately 38 gallons of 3% solution of salt water.

Prepared by K. Strayer
Checked by [signature] 12-1-59
Approved by H A Holmes 12-1-59

Report No. 330-6
Date 17 November 1959
EDP 829

REVISED

2. A cyclic pressure set-up was plumbed to the cube as shown in photograph BWA-13374, page 20. The fluid temperature was raised to +140 ±5°F and maintained for 74 hours before pressure cycling was begun.

3. During the following 46 hours, the cube was pressure cycled from +6 to -1.5 to +6 psig at the rate of one complete cycle every 3 minutes, with approximately equal time on both positive and negative pressure.

4. The remainder of the aging test, approximate 46 hours, was completed after completion of the pressure cycling.

5. The test cube satisfactorily passed the aging and pressure cycling test without leakage.

C. Hot Air Dry (Data, page 11)

1. The test cube was drained, one access door removed and the sealant inspected. There was no apparent damage.

2. The cube was then placed in an environment of circulating 160°F ±5°F hot air for 78 hours.

D. Leakage Test (Data, page 12)

1. The test cube was filled with dyed JP-4 test fuel. A head tank was used to assure a full cube when 11 psig pressure was applied for 24 hours.

2. A slight leak developed at a fuel dam on the upper surface. This leak remained throughout the leakage test. A minute leak also appeared on the side of the cube but never became moist.

3. The leakage which appeared during this test was not of sufficient quantity to be significant.

E. Slosh and Vibration Test (Data, pages 13 through 18)

1. The Finish System test cube was mounted on a slosh and vibration table with the sides representing the spars at an angle of 30° to, and in a plane parallel with, the axis of rotation. See photograph BWA-13804, page 21 .

2. The plumbing system was assembled to obtain a fuel temperature of -65° ±5°F during the test. The tank was vented with a 1 1/4 vent line to atmosphere. No pressure was applied during this test.

3. The cube was filled with approximately 80 gallons of MIL-H-3136, Type I test fluid. When the fuel reached a temperature of -65° ±5°F, the cube was simultaneously slosh and vibrated for 25 hours

REVISED

at an average double amplitude of .032 inches and a frequency of 1960 CPM. The slosh rate was 11 CPM. After 2, 5, 9, 14, and 19 hours elapsed time, the test was momentarily stopped for visual inspection of the exterior of the cube. After a total of 25 hours of slosh and vibration, the access door was removed and the sealant was inspected by Process personnel. There were no sealant discrepancies.

4. Upon completion of the slosh and vibration test, the cube was sloshed only for 15 hours with approximately 80 gallons of MIL-H-3136, Type I test fluid at a temperature of -65°F.

5. No leakage occurred during the test.

F. Leakage Test (See data, page 19)

1. The cube was filled with JP-4. A pressure of 11 psig was applied to the cube for 24 hours.

2. Immediately after applying pressure, the cube began leaking at the intersection of the third rib stiffener and the fuel dam on the right hand side of the cube looking toward the access door marked "Top". The leak appeared to be from a huck bolt or self sealing fastener with a rate of 10 to 15 drops per hour.

G. Inspection

The sealant was inspected by Process Unit personnel at completion of the testing. Several sections of sealant have been removed for additional investigation.

III. The test cube has been placed in storage at the Power Plant Laboratory.

IV. All work by the Test Group as requested in EDP 829 (LT 829-3-3) has been completed. No additional testing on this particular finish system test cube is scheduled to be performed at this time.

REVISED

FORM E-1686 R2

DATE	TIME	PRESS PSI	REMARKS	INITIAL
9-21-59	1400	0	Started filling cube with JP4	
	1410	0	Finished filling cube	
	1425		Applied 11 PSI (22 in Hg)	
	1430	11	CUBE LEAKS LOWER STRINGER BOTH	
			SIDES + THREE SMALLER LEAKS	[illegible]
	1500	11	INSPECTED BY SEALANTS LAB.	[illegible]
	1515	0	DRAINED FUEL	[illegible]
	1600	0	REMOVED TOP ACCESS DOOR	[illegible]
9-22-59	0945		SEALANT'S LAB. TECH. STARTED	
			REPAIRING SEALER LEAKS.	[illegible]
9-24-59		4	PRESS. Checked OK	E.L.
9-28-59	1200		Started Filling cube with JP-4	[illegible]
	1210	11 PSI	Cube Filled + 11 PSI Applied	[illegible]
	1325	11 PSI	CORNER LEAK BOTTOM.	[illegible]
	1600		RELIEVED PRESS. + DRAINED FUEL	[illegible]
9-29-59			TROTTER REPAIRED SEALER	[illegible]
9-30-59			DOOR INSTALLED BY TROTTER	[illegible]
5 OCT. 59	0945		DOOR TORQUED 60 inch lbs	[illegible]
	1100	11 PSI	ONE LEAK AT BOTTOM CORNER	WST
	1445		REMOVED DOOR FOR SEALER	[illegible]
	1630		REPAIRED SEALER - INSTALLED DOOR	[illegible]
7 OCT. 59	0845		DOOR TORQUED 60 INCH LBS.	[illegible]
	0930 AM		FILLED CUBE JP4.	[illegible]
	0945 AM		APPLIED PSI. 5. (NO LEAK)	[illegible]
	1030 AM		INCREASED TO 11 PSI.	WST.
	12 30 PM		NO LEAK	[illegible]
	2:30 PM		ONE SMALL SEEP AT UPPER LH REAR CORNER	WST
	17 00		11 PSI.	[illegible]
	1900	10½ psi	No Leaks	[illegible]
	2200	10½ psi	" "	[illegible]
10/8/9	0000	10¾	" "	[illegible]
"	0130	10¾	" "	[illegible]
	0200	10¾	" "	SR
	0300	10¾	" "	SR

			REVISED	DATE
CALC	[illegible]	11/20/59		
CHECK	[illegible]	12-1-59		
APD				
APR				

LEAKAGE TEST
FINISH SYSTEM IFT TEST CUBE

B-52

BOEING AIRPLANE COMPANY
WICHITA 1, KANSAS

CONTRACT NO.

REPORT NO. 330-6

PAGE 4 OF

REVISED

FORM E-1686 R2

DATE	TIME	PRESS -PSI	REMARKS	INITIAL
10/10/9	0400	11	NO LEAKS	SR
	0600	11	LEAK AT LOCATION MARKED #8	SR
	0700	11	LEAKS AT LOCATION MARKED #3 ALSO #8	SR
	0800	11	LEAKS AT LOCATION MARKED #1 #3 #8	SR
	0930	11	SEEPAGE AT ABOVE LOCATIONS + TOP DOOR.	[illegible]
	1030	11	LEAKAGE INSPECTED + MARKED BY SEALANT	
			LAB. - SHOWALTER + TROTTER.	
			LEAK #1-4" FROM TOP 1st STRINGER - FUEL DAM.	
			LEAK #2 - 3RD STRINGER FROM TOP - FUEL DAM	
			LEAK #3 - BETWEEN 3rd + 4th STRINGERS	
			LEAK #4 - TOP SIDE CORNER BOLTS OR	
			RIVETS	
			LEAK #5 - 3rd STRINGER FROM TOP - FUEL DAM	
			OPP. SIDE OF CUBE.	
			SEEPAGE ALSO AROUND TOP DOOR	[illegible]
	1045	-	RELIEVED PRESSURE + DRAINED	[illegible]
	1130		DOOR REMOVED + CUBE MOPPED OUT	[illegible]
	1600		SEALER REPAIRED BY SHOWALTER + TROTTER.	[illegible]
10-[illegible]	1430		REPLACED DOOR. JUST SNUGGED	[illegible]
			NOT TORQUED. TORQUE 10-12 MORN	
10-12	0845		TORQUED DOOR 70LB	[illegible]
	0945		FILLED CUBE JP4.	[illegible]
	1015		APPLIED 5 PSI. NO LEAK	[illegible]
	1030		" " 11 PSI	[illegible]
	1130		SLIGHT SEEP FRONT SPAR UPPER L.H. [illegible]	[illegible]
	1330		" " " "	[illegible]
	1630		" " " "	[illegible]
	1800	11	" " " " "	[illegible]
	2000	11	" " " "	[illegible]
	2200	11	" " " " "	[illegible]
	0000	11	" " " "	[illegible]
10/13/9	0100	11	" " " " "	[illegible]
	0200	11	" " "	SR
	0300	11	" " " " "	SR
	0400	11	SEEP LEAK FRONT SPAR TOP R.H. JOGGLE @ #8 FUEL DAM	SR

CALC	[illegible]	11/30/9	REVISED	DATE
CHECK	[illegible]	12-1-59		
APR				
APR				

LEAKAGE TEST
FINISH SYSTEM IFT TEST CUBE

B-52

BOEING AIRPLANE COMPANY
WICHITA 1, KANSAS

CONTRACT NO.

REPORT NO. 330-6

REVISED

FORM E-1686 R2

BOEING AIRPLANE COMPANY
WICHITA DIVISION

DATE	TIME	PRESS PSI	REMARKS	INITIAL
10/3?	0500	11	"	SR
—	0600	11	"	SR
	0700	11	LEAK AT: TOP DOOR FRONT SPAR	SR
	0800	11	" " " " " "	SR
	1015	0	DRAINED CUBE	[illegible]
	1100	0	MOPPED DRY. READY FOR SEALER	[illegible]
10-13-9	1500	0	INSTALLED DOOR. SNUG	[illegible]
			BE SURE TO TORQUE DOOR 10-15-59	
10-15-9	0945		TORQUED DOOR 70LB	[illegible]
	1045		FILLED CUBE JP4	[illegible]
	1100	11 PSI	APPLIED NO LEAKS	[illegible]
	1230	11 PSI	NO "	[illegible]
	1600	11 PSI	SLIGHT SEEP ON AN FITTING BOLTS	[illegible]
—	1800	11 psi	Slight seep on AN fitting [illegible]	[illegible]
	2000	11 psi	" " " " "	[illegible]
	2200	11 psi	" " " " "	[illegible]
10/16/9	00 00	11 psi	" " " " "	[illegible]
	0130	11 psi	" " " " "	[illegible]
	0200	11 PSI	" " " " "	SR
	0400	11 PSI	" " " ALSO ON TOP ROW OF RIVETS	
			ALONG SIDE OFF DOOR MARKED	SR
	0600	11 PSI	" " " " "	SR
	0700	11 PSI	" " " " "	SR
	0800	11 PSI	" " " " "	SR
	0930	11 PSI.	NO LEAKS - THE ABOVE LEAKS WERE FROM FITTING - (LOOSE NUT)	W.S.T.
	1130		DRAINED CUBE - END PHASE I	[illegible]

CALC	K.J.	11/20/9	REVISED	DATE
CHECK	[illegible]	12-1-59		
APR				
APR				

LEAKAGE TEST
FINISH SYSTEM 1FT TEST CUBE

B-52

BOEING AIRPLANE COMPANY
WICHITA 1, KANSAS

CONTRACT NO.

REPORT NO. 330-6

FORM E-1686 R2

REVISED

DATE	TIME	FUEL TEMP. °F	POSITIVE / NEGATIVE PRESS. "HG	CYCLES	CHAMBER TEMP. °F	REMARKS	INITIAL
20 OCT. 59	1600	INSTALLED TEST IN TEST CHAMBER					[illegible]
21 OCT. 59	1130	FILLED TEST WITH TEST FUEL					[illegible]
	1515	85°			133°		[illegible]
	1900	118°			140°		[illegible]
	2200	123°			140°		[illegible]
10/23/9	0000	126°			140°		[illegible]
	0130	128°			140		[illegible]
	0230	128°			138		SR
	0330	130			136		SR
	0430	133			136		SR
	0530	133			134		SR
	0630	134			134		SR
	0730	135			134		SR
	0830	135			134		SR
	1030	137			138		[illegible]
	1330	137			139		[illegible]
	1530	138			138		[illegible]
	1630	138			139		[illegible]
	1930	137			138		[illegible]
	2130	138			138		[illegible]
	0130	140			139		[illegible]
10/2[illegible]	0200	139			135		SR
	0300	139			136		SR
	0400	139			136		SR
	0500	139			137		SR
	0600	139			138		SR
	0700	139			138		SR
	0800	139			138		SR
	0840	139			138		[illegible]
	0845	138			138	STARTED CYCLING	[illegible]
	0945	138	+6/-1.5	19	138		[illegible]
	1005	137.5	+6/-15	47	138		[illegible]
	1215	138	+6/-15	69	139		[illegible]
	1335	138	+6/-15	96	140		[illegible]
	1535	138	+6/-15	136	140		[illegible]

CALC	[illegible]	11/20/9	REVISED	DATE
CHECK	[illegible]	12-1-59		
APR				
APR				

AGING & CYCLING TEST
FINISH SYSTEM IFT TEST CUBE

B-52

BOEING AIRPLANE COMPANY
WICHITA 1, KANSAS

CONTRACT NO.

REPORT NO. 330-6

REVISED

FORM E-1686 R2

DATE	TIME	FUEL TEMP. °F	PRESS. "HG	CYCLES		REMARKS	INITIAL
10-26-59	1630	138°	5.6/-1.5	154		No Leaks	[illegible]
	1730	138	[illegible]/-3.0	175		No Leaks	[illegible]
	1830	138	11.5/-3.0	196		No Leaks	[illegible]
	1930	139	11.4/-3.0	215		No Leaks	[illegible]
	2030	139	11.5/-3.0	235		No Leaks	[illegible]
	2130	140	11.4/-3.0	255		No Leaks	[illegible]
	2230	140	11.4/-3.0	274		No Leaks	[illegible]
	2330	140	11.4/-3.0	295		No Leaks	[illegible]
	2400	140	11.4/-3.0	~~295~~	305	" "	CBL
	2430	140	11.4/-3.0	~~244~~	315	" "	CBL
10/27	0130	140	11.5/-3.0	336		" "	[illegible]
	0200	140	11.5/-3.0	348		" "	CBL
	0300	140	11.5/3.0	360		" "	SR
	0400	140	11.5/3.0	385		" "	SR
	0500	140	11.5/3.0	406		" "	SR
	0600	140	11.5/3.0	428		" "	SR
	0700	141	11.5/3.0	449		" "	SR
	0800	141	11.5/3.0	467		" "	SR
	0900	141	12/3.2	486		" "	SR
	1000	140	11.4/3.0	506		" "	[illegible]
	1030	139		516		SHUT DOWN, REP. VAC.	[illegible]
	1400	139				" " " "	[illegible]
	1635	138°				RESTARTED CYCLING	[illegible]
	1720	138	11.3/3.0	534			EBL
	1830	139	11.3/3.0	557		No Leaks	[illegible]
	1940	139	11.3/3.0	579		No Leaks	[illegible]
	2100	140	11.3/3.0	608		No Leaks	[illegible]
	2240	140	11.3/3.0	640		No Leaks	EBL
10/28	0020	140	11.3/3.0	674		No Leaks	[illegible]
	0115	140	11.3/3.0	690		" "	[illegible]
	0200	142	11.4/3.1	707		" "	SR
	0300	142	11.3/3.1	727		" "	SR
	0400	142	11.3/3.1	750		" "	SR
	0500	143	11.3/3.1	768		" "	SR

			REVISED	DATE
CALC	[illegible]	11/20/59		
CHECK	[illegible]	12-1-59		
APR				
APR				

AGING & CYCLING TEST
FINISH SYSTEM IFT TEST CUBE

B-52

BOEING AIRPLANE COMPANY
WICHITA 1, KANSAS

CONTRACT NO.

REPORT NO. 330-6

PAGE 8
OF

REVISED

FORM E-1686 R2

DATE	TIME	TEMP. °F	POSITIVE/NEGATIVE PRESS. "HG	CYCLES	REMARKS	INITIAL
10/28/59	0600	143	11.3/3.0	790	NO LEAKS ADJUSTED VACUUM + HEAT	SR
	0700	143	11.3/3.0	807	NO LEAKS	SR
	0800	143	11.4/3.0	827	" "	SR
	0900	142	11.6/3.0	846		[illegible]
	1000	139	12/3.0	866		[illegible]
	1100	138	11.6/30	886		[illegible]
	1200	138	11.6/3.0	905		[illegible]
	1400	138	11.6/3.0	945		[illegible]
	1500	138	11.6/3.0	965		[illegible]
	1600	139	11.8/3.0	985		[illegible]
	1645	139	11.6/3.0	1000	STOP CYCLING	[illegible]
	1800	138				EBL
	2000	138				EBL
	2200	139				EBL
	2330	140				[illegible]
	2430	141				[illegible]
10/29	0100	141				[illegible]
	0200	142				SR
	0300	142				SR
	0400	142				SR
	0500	141				SR
	0600	139				SR
	0700	139				SR
	0800	139				SR
	1000	139				[illegible]
	1200	139				[illegible]
	1400	138				[illegible]
	1500	138				[illegible]
	1600	138				[illegible]
	1700	138				[illegible]
	1900	138				EBL
	2100	138				[illegible]
	2300	140				EBL
10/30	0145	139				EBL
	0300	138				SR

			REVISED	DATE
CALC	[illegible]	11/20/59		
CHECK	[illegible]	12-1-59		
APR				
APR				

AGING & CYCLING TEST
FINISH SYSTEM IFT TEST CUBE

B-52

BOEING AIRPLANE COMPANY
WICHITA 1, KANSAS

CONTRACT NO.

REPORT NO. 330-6

FORM E-1686 R2

REVISED

DATE	TIME	TEMP. °F	POSITIVE NEGATIVE PRESS. HG	CYCLES	REMARKS	INITIAL
10/30	0400	138			NO LEAKS	SR
	0500	138			NO LEAKS	SR
	0600	139			" "	SR
	0700	140			" "	SR
	0730	140				EWG
	0800	141				SR
	0845	141			END PHASE II	EEW

CALC	RJ	11/20/59	REVISED / DATE
CHECK	[illegible]	12-1-59	
APR			
APR			

AGING & CYCLING TEST
FINISH SYSTEM IFT TEST CUBE

B-52

BOEING AIRPLANE COMPANY
WICHITA 1, KANSAS

CONTRACT NO.

REPORT NO. 330-6

FORM E-1686 R2

REVISED

DATE	TIME	TEMP	REMARKS	INITIAL
30 OCT. 59	1600		TEST INSTALLED IN MED. SIZE TEST CHAMBER	[illegible]
	1800	145		EBL
	1900	153		EBL
	2200	155		EBL
	2400	156		EBL
10/31/59	0145	158		[illegible]
11/2/59	0200	159		[illegible]
	0300	159		SR
	0400	159		EW
	0500	159		EW
	0600	158		SR
	0700	158		SR
	1000	158		[illegible]
	1200	156		[illegible]
	1400	156		[illegible]
	1600	156		[illegible]
	1800	157		EBL
	1900	157		EBL
	2000	157		EBL
	2100	157		EBL
	2200	157	Turned OFF heat. Opened Door. END PHASE III	EBL

CALC	[illegible]	11/20/59	REVISED	DATE	HOT AIR DRY PNMSA SYSTEM IFT TEST CUBE	B-52
CHECK	[illegible]	12-1-59			BOEING AIRPLANE COMPANY WICHITA 1, KANSAS	
APR						PAGE
APR						OF

CONTRACT NO.

REPORT NO. 330-6

FORM E-1686 R2

DATE	TIME	PRESS PSI	REMARKS	INITIAL
4 Nov. 59	1330	11 PSI	CUBE FILLED WITH JP4. PRESS. APPLIED	EEM
	1515	10.8 PSI	NO VISIBLE LEAKAGE	EEM
	1630	11.0 PSI	SEEPAGE 2nd FUEL DAM FROM TOP DOOR, TOP SIDE	EEM
	1830	11.0	NO visible leaks	EBL
	1930	10.8	" " "	EBL
	2030	10.9	" " "	EBL
	2130	10.8	" " "	EBL
	2230	11.1		EBL
	2330	11.1		EBL
	2430	11.1		EBL
5 Nov. 59	0130	11.2		EBL
	0230	11.3	LEAK ON S. SIDE AT POS # III	SR
	0330	11.3	" " "	SR
	0430	11.2	" " "	SR
	0530	11.2	" " "	SR
	06:30	11.2	"	SR
	07:30	11.2		SR
	08:30	11.2	" " " "	SR
	10 15	11.0	" " "	SR
	11 30	10.6		[illegible]
	13 30		DRAINED JP4.	[illegible]

CALC	[illegible]	11/23/59	REVISED	DATE
CHECK	[illegible]	12-1-59		
APR				
APR				

LEAKAGE TEST
FINISH SYSTEM IFT TEST CUBE

B-52

BOEING AIRPLANE COMPANY
WICHITA 1, KANSAS

CONTRACT NO.

REPORT NO. 330-6

PAGE 72
OF

REVISED

FORM E-1686 R2

DATE	TIME START	TIME TOTAL	SLOSH RATE CPM	VIBRATION FREQ.	AMP I (INCHES)	AMP III (INCHES)	FUEL TEMP °F	REMARKS	INITIAL
11 Nov. 59	1800		11		.032	0		STARTED COOLING	EBL
	1800	0	11	2000	.038	.026	-65	Slosh & Vibrate	EBL
	1815				.036	.025	-65		EBL
	1830				.035	.025	-64		EBL
	1845				.035	.024	-63		EBL
	1900	1 hour			.037	.025	-65		EBL
	1915				.039	.025	-65		EBL
	1930				.037	.024	-64		EBL
	1945				.036	.025	-64		EBL
	2000	2 hrs.			.037	.025	-65	Stopped to Insp.	EBL
	2015	2 hrs.			.037	.025	-61	Slosh & Vibrate	EBL
	2030				.036	.024	-65		EBL
	2045				.039	.025	-65		EBL
	2100				.038	.025	-65		EBL
	2115	3 hrs.			.038	.025	-64		EBL
	2130				.037	.025	-62		EBL
	2145				.038	.025	-62		EBL
	2200				.037	.026	-63		EBL
	2215	4 hrs.			.038	.026	-63		EBL
	2230				.036	.026	-61		EBL
	2245				.038	.026	-65		EBL
	2300				.039	.025	-65		EBL
	2315	5 hrs.			.036	.026	-63	Stopped to Insp.	EBL
	2330	5 hrs.			.036	.026	-61	Slosh & Vibrate	EBL
	2345				.037	.025	-65		EBL
	2400				.037	.026	-64		EBL
12 Nov. 59	0015				.038	.026	-62		EBL
	0030	6 hrs.			.038	.026	-62		EBL
	0045				.037	.026	-62		EBL
	0100				.036	.027	-62		EBL
	0115				.038	.026	-62		EBL
	0130	7 hrs.			.036	.028	-64		EBL
	0145	7 hr. 15 min.			.036	.028	-63	Stopped Test because of end of shift	EBL

CALC	KS	4/20/9	REVISED / DATE
CHECK	[illegible]	12-1-59	
APR			
APR			

SLOSH & VIBRATION TEST
FINISH SYSTEM IFT TEST CUBE

B-52

BOEING AIRPLANE COMPANY
WICHITA 1, KANSAS

CONTRACT NO.

REPORT NO. 330-6

PAGE 13 OF

REVISED

DATE	TIME START	TIME TOTAL	SLOSH RATE CPM	VIBRATION FREQ.	AMP I (INCHES)	AMP III (INCHES)	FUEL TEMP °F	REMARKS	INITIAL
11-12-59	0900	7:30	11	2000	[illegible]	.036	-65	RESTARTED TEST	[illegible]
	0915	7:45	11		[illegible]	[illegible]	-64		[illegible]
	0930	8:00	11		.038	.024	-64		[illegible]
	0945	8:15			.037	.023	-63		[illegible]
	1000	8:30			.038	.022	-62		[illegible]
	1020	8:50			.033	.020	-61		[illegible]
	1030	9:00			.034	.020	-64	STOPPED TO INSP. SLOSH & VIBRATION	[illegible]
	1045	9:00			.032	.023	-62	RESTARTED TEST	[illegible]
	1100	9:15			.035	.024	-62		[illegible]
	1115	9:30			.034	.022	-65		[illegible]
	1130	9:45			.039	.024	-64		[illegible]
	1145	10:00			.033	.020	-65		[illegible]
	12:00	10:15			.032	.020	-64		[illegible]
	12:15	10:30			.032	.020	-62		[illegible]
	12:30	10:45			.035	.019	-64		[illegible]
	12:45	11:00			.03[illegible]	.018	-65		[illegible]
	1300	11:15	11	2000	.038	.026	-64		[illegible]
	1315	11:30	11	2000	.038	.027	-64		[illegible]
	1330	11:45	11	2000	.038	.027	-65		[illegible]
	1345	12:00	11	2000	.038	.024	-65		[illegible]
	1400	12:15	11	2000	.038	.022	-64		[illegible]
	1415	12:30	11	2000	.037	.022	-64		[illegible]
	1430	12:45	11	2000	.037	.021	-65		[illegible]
	1445	13:00	11	2000	.035	.020	-65		[illegible]
	1500	13:15	11	2000	.033	.020	-65		[illegible]
	1515	13:30	11	2000	.033	.021	-64		[illegible]
	1530	13:45	11	2000	.037	.024	-62		[illegible]
	1545	14:00	11	2000	.036	.023	-63	STOP. FOR INSP.	[illegible]
	1615	14:00	11	2000	[illegible]	[illegible]	-63	RESTART TEST	[illegible]
	1630	14:15	11	2000	.044	.019	-62		[illegible]
	1645	14:30	11	2000	.040	.020	-63		[illegible]
	1700	14:45	11	2000	.035	.019	-64		[illegible]
	1715	15.00			.041	.023	-62		[illegible]
	1730	1515			.041	.021	-63		[illegible]
	1745	1530			.040	.022	-64		[illegible]

CALC	[illegible]	11/20/59	REVISED	DATE	SLOSH & VIBRATION TEST FINISH SYSTEM IFT TEST CUBE — B-52
CHECK	[illegible]	12-1-59			BOEING AIRPLANE COMPANY, WICHITA 1, KANSAS
APR					
APR					

CONTRACT NO.

REPORT NO. 330-6

REVISED

FORM E-1686 R2

DATE	TIME START	TIME TOTAL	SLOSH RATE CPM	VIBRATION FREQ.	VIBRATION AMP I INCHES	VIBRATION AMP III INCHES	FUEL TEMP. °F	REMARKS	INITIAL
12 Nov. 59	1800	15 hr. 45 min	11	2000	.041	.023	-62		[illegible]
	1815	16 hrs.	"		.042	.022	-62		[illegible]
	1830	"			.042	.021	-61		[illegible]
	1845	"	"		.041	.021	-63		[illegible]
	1900		"		.040	.022	-65		[illegible]
	1915	17 hrs.			.041	.021	-63		[illegible]
	1930				.042	.021	-63		[illegible]
	1945				.042	.022	-61		[illegible]
	2000				.038	.022	-62		[illegible]
	2015	18 hrs.			.042	.021	-64		[illegible]
	2030				.041	.022	-63		[illegible]
	2045				.043	.021	-63		[illegible]
	2100				.040	.021	-62		[illegible]
	2115	19 hrs.			.039	.021	-64	Stopped to Insp.	[illegible]
	2130	19 hrs.			.040	.025	-61	Restarted Test	[illegible]
	2145				.039	.023	-62		[illegible]
	2200				.040	.025	-64		[illegible]
	2215				.039	.024	-65		[illegible]
	2230	20 hrs.			.041	.024	-63		[illegible]
	2245				.041	.023	-61		[illegible]
	2300				.041	.023	-61		[illegible]
	2315				.040	.022	-61		[illegible]
	2330	21 hrs.			.040	.023	-62		[illegible]
	2345				.041	.022	-63		[illegible]
	2400				.041	.022	-61		[illegible]
	0015				.039	.021	-64		[illegible]
	0030	22 hrs.			.042	.021	-65		[illegible]
	0045				.041	.021	-65		[illegible]
	0100				.041	.021	-64		[illegible]
	0115				.041	.022	-62		[illegible]
	0130	23 hrs.			.040	.022	-61		[illegible]
	0145	23.15			.041	.021	-62	Stopped Test	[illegible]
13 NOV 59	10:30		11	2000	.039	.022	-62	RESTARTED TEST	[illegible]
	10:45	23:30	11	2000	.040	.022	-64		[illegible]
	11:00	23:45	11	2000	.0[illegible]	.021	-65		[illegible]

CALC	[illegible]	12/2/59	REVISED	DATE	SLOSH & VIBRATION TEST FINISH SYSTEM IFT TEST CUBE	B-52
CHECK	[illegible]	12-7-59				
APR					BOEING AIRPLANE COMPANY WICHITA 1, KANSAS	
APR						

CONTRACT NO. REPORT NO. 330-6

FORM E-1686 R2

REVISED

DATE	TIME START	TIME TOTAL	SLOSH RATE CPM	VIBRATION FREQ.	AMP I (INCHES)	AMP III (INCHES)	FUEL TEMP °F	REMARKS	INITIAL
Nov 13	11:15	24:[illegible]	11	2000	.041	.081	-65		[illegible]
	11:30	24:15	11	2000	.042	.020	-64		[illegible]
	11:45	24:[illegible]	11	2000	.041	.020	-64		[illegible]
	12:00	24:[illegible]	11	2000	.042	.019	-63		[illegible]
	12:15	25:00	11	2000	.041	.019	-63		[illegible]

CALC	[illegible]	11/20/[illegible]	REVISED	DATE
CHECK	[illegible]	[illegible]		
APR				
APR				

SLOSH & VIBRATION TEST
FINISH SYSTEM IFT TEST CUBE

B-52

BOEING AIRPLANE COMPANY
WICHITA 1, KANSAS

CONTRACT NO.

REPORT NO. 330-6

FORM E-1686 R2

REVISED

DATE	TIME	TOTAL TIME	TEMP °F	SLOSH CYCLES PER MIN	REMARKS	INITIAL
11-16-9	11:35		+62	11	STARTED COOLING	D.S.
11-16-59	2:00		-65		STARTED TEST	[illegible]
	2:15		-62			D.S.
	2:30		-65			D.S.
	2:45		-63			D.S.
	3:00	1 hr	-64	11		[illegible]
	3:15	1 3 2	-63			[illegible]
	3:30		-62			[illegible]
	3:45		-62			[illegible]
	4:00	2 hrs	-65	11		D.S.
	4:15		-65			D.S.
	4:30		-64			D.S.
	4:45		-63			D.S.
	5:00	3 hrs	-65	11	SHUT DOWN FOR THE DAY	D.S.
11-17-59	9:00		-15		STARTED COOLING	[illegible]
	10:00		-65		STARTED TEST	[illegible]
	10:15		-65			[illegible]
	10:30		-64			[illegible]
	10:45		-63			[illegible]
	11:00	4 hrs	-62	11		[illegible]
	11:30		-65			[illegible]
	12:00	5 hrs	-65	11	STOPPED FOR LUNCH	[illegible]
	1:15		-62		RESTARTED TEST	[illegible]
	1:45		-65			[illegible]
	2:15	6 hrs	-64	11		[illegible]
	2:45		-64			[illegible]
	3:15	7 hrs	-64	11		[illegible]
	3:45		-63		PHOTOS TAKEN OF	[illegible]
	4:15	8 hrs	-65	11	SET UP AT 4:00 PM	[illegible]
	5:00	8 hrs 45 min	-64	11	SHUT DOWN FOR THE DAY	[illegible]
11-18-9	9:00		+35		STARTED COOLING	[illegible]
	9:20		-65		STARTED TEST	[illegible]
	10:00	9 hrs 25 min	-65	11		[illegible]
	10:30		-64			[illegible]
	11:00	10 hrs 25 min	-62	11		[illegible]

CALC	[illegible]	11/23/59	REVISED	DATE
CHECK	[illegible]	12-1-59		
APR				
APR				

SLOSH TEST
FINISH SYSTEM IFT TEST CUBE

B-52

DATE	TIME	TOTAL TIME	TEMP. °F	SLOSH CYCLES PER MIN	REMARKS	INITIAL
11-18-59	11:30	1055	-62	11		[illegible]
	12:00	11 25	-63	11	SHUT DOWN FOR LUNCH	[illegible]
	1:00	11 25	-61		RESTARTED TEST	[illegible]
	1:30		-65			[illegible]
	2:00	12 25	-63	11		[illegible]
	2:30		-66	11		[illegible]
	3:00	13:25	-62	11		[illegible]
	3:30		-65	11		[illegible]
	4:00	14.25	-62	11		[illegible]
11-18-59	4:35	15 hr	-64	11	END OF TEST	[illegible]

			REVISED	DATE
CALC	[illegible]	11/23/59		
CHECK	[illegible]	12-1-59		
APR				
APR				

SLOSH TEST
FINISH SYSTEM IFT TEST CUBE

B-52

BOEING AIRPLANE COMPANY
WICHITA 1, KANSAS

CONTRACT NO.

REPORT NO. 330-6

FORM E-1686 R2

REVISED

DATE	TIME	TEMP	PRESS PSI	REMARKS	INITIAL
11-11-59	10.55		11PSIG	Started press	[illegible]
	1:00		10.7PSIG	LEAK BETWEEN THIRD & FOURTH STRINGER FROM ACCESS DOOR AT DOUBLE ROW OF RIVETS BELOW TOP FUEL DAM	[illegible]
	3:00		11 PSIG		[illegible]
	5:00		11 PSIG		[illegible]
	7:00 pm		11 psig	same leakage mentioned above	[illegible]
	9:00 pm		11 psi	NO change	[illegible]
	11:00 pm.		11	" "	[illegible]
20 Nov.	0100		11	" "	[illegible]
	8:30		11	" "	[illegible]
	10:30		11	LEAK IN LOWER PANEL AT DOUBLE ROW OF RIVETS & SPLICE	[illegible]
	11.00		11	NO CHANGE END OF TEST	[illegible]
				OPENED CUBE FOR PROCESS UNIT SEALANT INSPECTION	

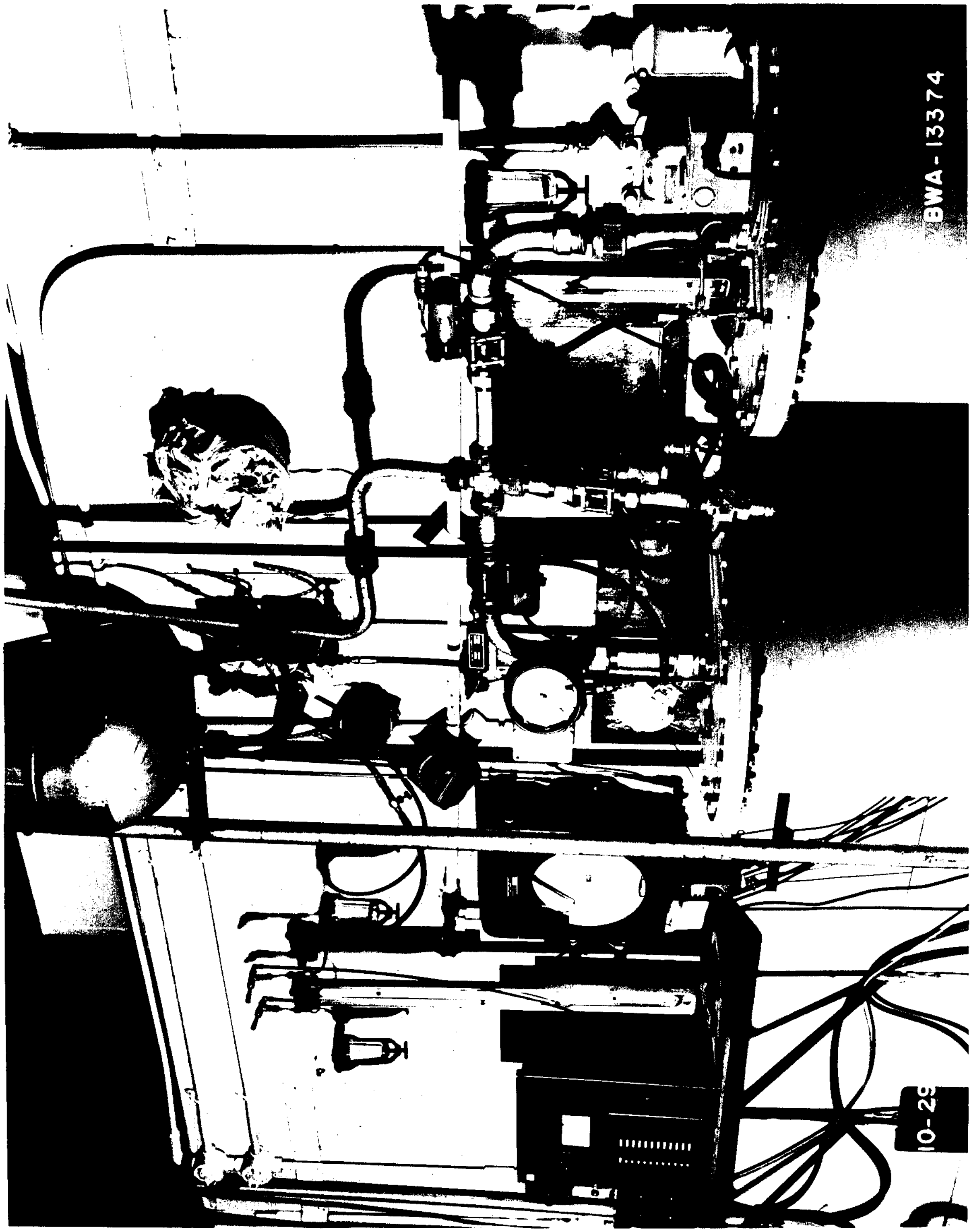
CALC	[illegible]	11-27-59	REVISED	DATE	LEAKAGE TEST FINISH SYSTEM IFT TEST CUBE	B-52
CHECK	[illegible]	12-1-59			BOEING AIRPLANE COMPANY WICHITA 1, KANSAS	
APR						
APR						

CONTRACT NO.

REPORT NO. 330-6

REVISED

FORM E-1686 R2



REVISED

FORM E-1686 R2